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A SKETCH
OF THE
GEOGRAPHY AND GEOLOGY
OF THE
HIMALAYA MOUNTAINS AND TIBET

BY
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PART I
THE HIGH PEAKS OF ASIA



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PREFACE

IN 1807 a Survey detachment was deputed by the Surveyor General of Bengal to explore the source of the Ganges: this was the first expedition to the Himalaya undertaken for purely geographical purposes. A hundred years have now elapsed, during which geographical and geological information has been steadily accumulating and we have at length reached a stage where there is danger of losing our way in a maze of unclassified detail: it is therefore desirable to review our present position, to co-ordinate our varied observations and to see how far we have progressed and what directions appear favourable for future lines of advance.

The present paper originated in a proposal submitted by the Survey of India to the Board of Scientific Advice at the meeting of the latter in May 1906. The proposal was as follows:—"The number of travellers in the Himalaya and Tibet is increasing, and a wider interest is being evinced by the public in the geography of these regions. It is therefore proposed to compile a paper summarising the geographical position at the present time."

Subject to the modification that the scope of the paper should be geological as well as geographical, this proposal has received the sanction of the Government of India and the work has been entrusted to us to carry out. On the understanding that the paper is intended primarily for the use of the public, we have endeavoured to avoid purely technical details and to present our results in a popular manner.

Our subject has fallen naturally into four parts, as follows:—

PART I.—The high peaks of Asia.

PART II.—The principal mountain ranges of Asia.

PART III.—The rivers of the Himalaya and Tibet.

PART IV.—The geology of the Himalaya.

Though the four parts are essentially interdependent, each has been made as far as possible complete in itself and will be published separately. The first three parts are mainly geographical, the fourth part is wholly geological: the parts are subdivided into sections, and against each section in the table of contents is given the name of the author responsible for it.

PREFACE

The endeavour to render each part complete must be our apology for having repeated ourselves in more places than one: the relations, for instance, of a range to a river have been discussed in Part II, when the range was being described, and have been mentioned again in Part III under the account of the river.

As the mountains of Asia become more accurately surveyed, errors will doubtless be found in what we have written and drawn: it is not possible yet to arrive at correct generalisations and we have to be content with first approximations to truth.

Maps, too large for insertion in such a volume as this, are required for a study of the Himalayan mountains: the titles of maps illustrating the text are given in foot-notes and are procurable from the Map Issue Office of the Survey of India in Calcutta. Constable's hand-atlas of India will be found useful.

We are much indebted to Babus Shiv Nath Saha and Ishan Chandra Dev, B.A., for the care with which they have checked our figures and names, and to Mr. J. H. Nichol for the trouble he has taken to ensure the correctness of the charts. Mr. Eccles and Major Lenox Conyngham have been kind enough to examine all proofs, and to give us the benefit of their advice and suggestions. Mr. Eccles has also supervised the drawing and printing of the charts, and we have profited greatly by the interest he has shown in them.

S. G. BURRARD.

H. H. HAYDEN.

March 1907.

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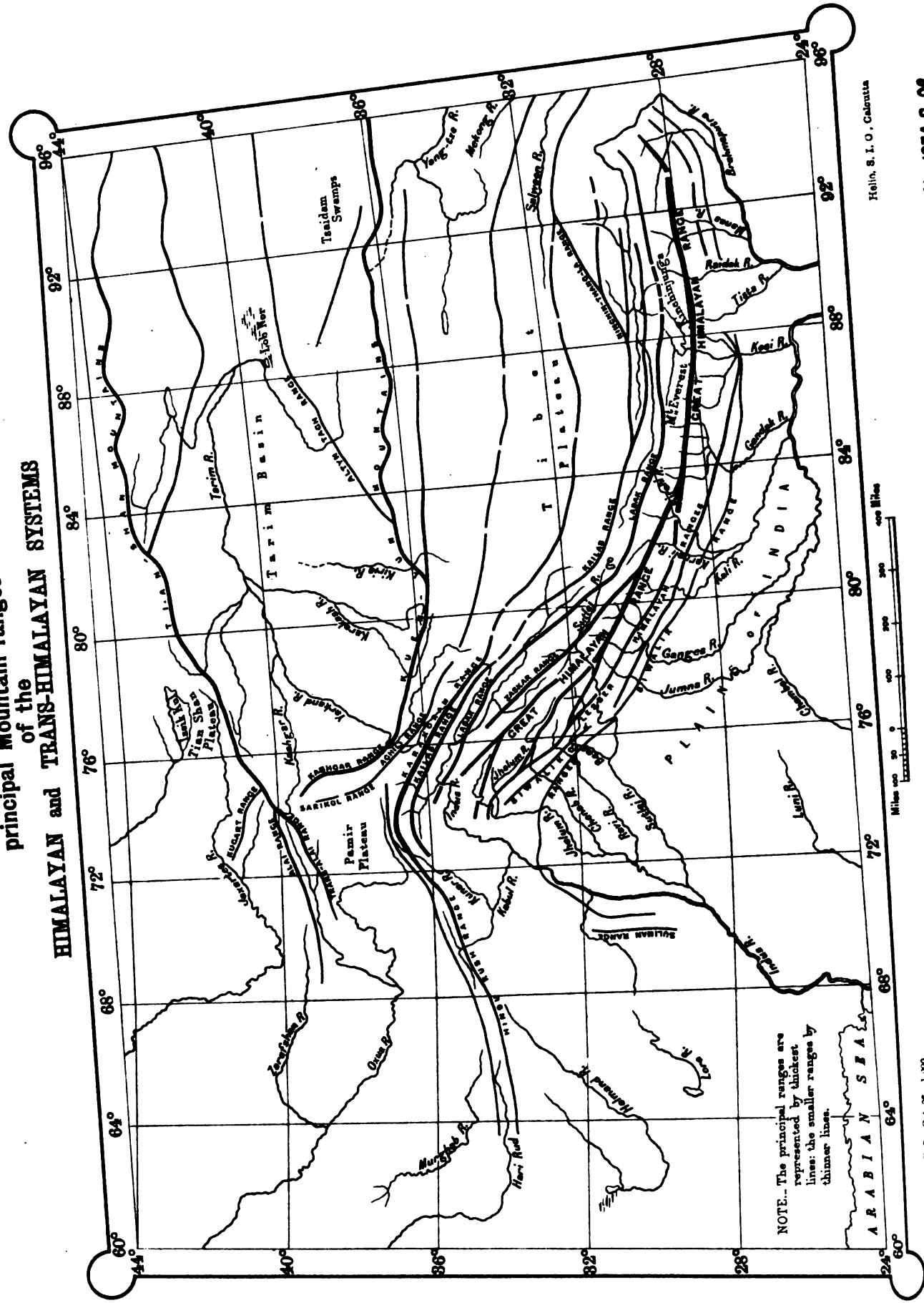
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FRONTISPIECE.

CHART to illustrate the TRENDS of the principal Mountain ranges of the HIMALAYAN and TRANS-HIMALAYAN SYSTEMS



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THE HIGH PEAKS OF ASIA.

1

THE PRINCIPAL PEAKS AND THEIR ALTITUDES.

IN the earlier stages of geographical investigation the most important features of a mountain mass are the high peaks. They may be, it is true, but slight prominences of lofty ranges and they may possess perhaps no geological significance : but they are conspicuous and definite points ; they are the only mountain features that can be observed with accuracy from a distance ; and the determination of their positions and heights is the first step of the ladder of geographical knowledge. When this step has been taken, further progress becomes possible ; the peaks can be made the basis of subsequent surveys ; the courses of rivers and the positions of lakes can be laid down with regard to them ; the trends and forms and magnitudes of the ranges can be inferred from the distribution of the peaks.

In the following tables I to V all the peaks of Asia that have been found to exceed 24000 feet in height are catalogued in order of magnitude : their geographical positions are shown in the five corresponding charts, numbered also I to V.*

TABLE I.—Peaks of the first magnitude exceeding 28000 feet in height.

Reference number of Peak.	Name or symbol.	Height.	Number of stations from which the height was observed.	Latitude.	Longitude.†	Mountain range.
		<i>feet</i>		° ' "	° ' "	
1	Mount Everest ..	29002	6	27 59 16	86 55 40	Nepal Himalaya
2	K ² ..	28250	9	35 52 55	76 30 51	Karakoram
3	Kinchinjunga I ..	28146	9	27 42 9	88 9 0	Nepal Himalaya

* Those peaks only have been included the heights of which are known with fair accuracy. Peaks the heights of which have been conjectured by explorers to exceed 24000 feet have been omitted.

† The values of longitude are based on the determination of the difference between Greenwich and Madras made in 1894-96, and are not those hitherto accepted by the Survey of India.

TABLE II.—Peaks of the second magnitude between 27000 and 28000 feet in height.

Reference number of Peak.	Name or symbol.	Height.	Number of stations from which the height was observed.	Latitude.	Longitude.*	Mountain range.
		<i>feet</i>		° ' "	° ' "	
4	Kinchinjunga II ..	27803	7	27 41 30	88 9 24	Nepal Himalaya
5	Makalu	27790	6	27 53 23	87 5 29	Nepal Himalaya

TABLE III.—Peaks of the third magnitude between 26000 and 27000 feet in height.

Reference number of Peak.	Name or symbol.	Height.	Number of stations from which the height was observed.	Latitude.	Longitude.*	Mountain range.
		<i>feet</i>		° ' "	° ' "	
6	T ⁴⁵	26867	3	28 5 32	86 39 51	Nepal Himalaya
7	Dhaulagiri ..	26795	7	28 41 48	83 29 42	Nepal Himalaya
8	XXX	26658	3	28 33 0	84 33 43	Nepal Himalaya
9	Nanga Parbat I ..	26620	8	35 14 21	74 35 24	Punjab Himalaya
10	XXXIX	26492	8	28 35 44	83 49 19	Nepal Himalaya
11	K ⁶ or Gasherbrum I ..	26470	4	35 43 30	76 41 48	Karakoram
12	K ⁴ or Gasherbrum II ..	26360	2	35 45 31	76 39 15	Karakoram
13	Gosainthan	26291	2	28 21 7	85 46 55	Nepal Himalaya
14	K ^{3a} or Gasherbrum III	26090	2	35 45 36	76 38 33	Karakoram
15	XXXIV	26041	5	28 32 5	84 7 26	Nepal Himalaya
16	K ³ or Gasherbrum IV	26000	2	35 45 38	76 37 2	Karakoram

* The values of longitude are based on the determination of the difference between Greenwich and Madras made in 1894-96, and are not those hitherto accepted by the Survey of India.

TABLE IV.—Peaks of the fourth magnitude between 25000 and 26000 feet in height.

Reference number of Peak.	Name or symbol.	Height.	Number of stations from which the height was observed.	Latitude.	Longitude.*	Mountain range.
		<i>feet</i>		° ' "	° ' "	
17	T ⁵⁷ ..	25990	1	28 5 52	86 44 41	Nepal Himalaya
18	B ⁷⁸² ..	25909	1	28 6 24	86 41 15	Nepal Himalaya
19	XXVIII ..	25801	4	28 26 3	84 38 34	Nepal Himalaya
20	Kambachen ..	25782	4	27 42 59	88 6 47	Nepal Himalaya
21	XXIX ..	25705	2	28 30 12	84 34 7	Nepal Himalaya
22	Masherbrum East ..	25660	7	35 38 36	76 18 31	Karakoram
23	Nanda Devi ..	25645	9	30 22 32	79 58 22	Kumaun Himalaya
24	Masherbrum West ..	25610	3	35 38 29	76 18 23	Karakoram
25	Nanga Parbat II ..	25572	2	35 15 22	74 35 14	Punjab Himalaya
26	LIX ..	25563	3	30 22 34	79 58 18	Kumaun Himalaya
27	Rakapozhi ..	25550	3	36 8 39	74 29 22	Kailas
28	Kunjut No. 1 ..	25460	2	36 12 21	75 25 3	Karakoram
29	Kamet ..	25447	6	30 55 13	79 35 37	Zaskar
30	T ⁴² ..	25433	1	28 6 36	86 37 18	Nepal Himalaya
31	XLIII ..	25429	5	28 45 45	83 23 25	Nepal Himalaya
32	Tirich Mir I ..	25426	2	36 15 17	71 50 25	Hindu Kush
33	N ⁵³ ..	25413	2	27 55 47	87 6 44	Nepal Himalaya
34	K ¹⁰ ..	25400	4	35 24 1	76 50 55	Karakoram
35	Hunza-Kunji I ..	25370	2	36 30 30	74 31 21	Karakoram
36	Gurla Mandhata ..	25355	2	30 26 18	81 17 57	Ladak
37	Jano ..	25294	9	27 40 56	88 2 47	Nepal Himalaya
38	K ¹¹ ..	25280	4	35 24 24	76 50 50	Karakoram
39	XLIV ..	25271	3	28 45 13	83 22 46	Nepal Himalaya
40	B ⁷⁸³ ..	25202	1	28 5 50	86 42 31	Nepal Himalaya
41	Shyok Nubra Watershed No. 5 ..	25170	1	34 52 2	77 45 13	Karakoram
42	Kungur I ..	25146	2	38 39 23	75 13 5	Kashgar
43	B ⁵⁰⁴ ..	25134	2	28 21 17	85 48 45	Nepal Himalaya
44	Hunza-Kunji II ..	25118	1	36 31 59	74 30 4	Karakoram
45	Karakoram No. 8 ..	25110	4	35 36 44	76 34 23	Karakoram
46	XLVI ..	25064	7	28 44 7	83 18 53	Nepal Himalaya
47	Hunza-Kunji III ..	25050	2	36 26 32	74 40 53	Karakoram
48	Kungur II ..	25046	2	38 37 4	75 19 39	Kashgar

*The values of longitude are based on the determination of the difference between Greenwich and Madras made in 1894-96 and are not those hitherto accepted by the Survey of India.

TABLE V.—Peaks of the fifth magnitude between 24000 and 25000 feet in height.

Reference number of Peak.	Name or symbol.	Height.	Number of stations from which the height was observed.	Latitude.	Longitude.*	Mountain range.
		<i>feet</i>		° ' "	° ' "	
49	XLV	24885	5	28 44 3	83 21 51	Nepal Himalaya
50	XXXVI	24750	4	28 35 3	83 59 31	Nepal Himalaya
51	Kulha Kangri I ..	24740	4	28 2 49	90 27 30	Assam Himalaya
52	Karakoram No. 5 ..	24690	1	35 8 54	77 34 41	Karakoram
53	XXXV	24688	4	28 32 11	84 5 5	Nepal Himalaya
54	Kulha Kangri II ..	24660	1	28 4 11	90 26 53	Assam Himalaya
55	Shyok Nubra Watershed No. 3	24650	2	34 48 14	77 48 22	Karakoram
56	Tirich Mir II ..	24611	2	36 25 52	71 50 11	Hindu Kush
57	Shyok Nubra Watershed No. 4	24590	2	34 50 31	77 47 16	Karakoram
58	Kunjut No. 2 ..	24580	1	36 12 45	75 15 12	Karakoram
59†	R ²⁶⁴	24496	2	28 13 52	90 37 10	Assam Himalaya
60	Indus-Nagar Watershed No. 2	24470	2	36 0 14	74 52 34	Kailas
61	LVII	24391	3	30 21 58	79 59 54	Kumaun Himalaya
62	Muztagh Ata ..	24388	2	38 16 43	75 7 6	Kashgar
63	K ¹³	24370	4	35 17 46	77 1 23	Karakoram
64	A satellite of Kinchin-junga	24344	5	27 52 40	88 8 35	Nepal Himalaya
65	Tirich Mir III ..	24343	2	36 23 31	71 53 43	Hindu Kush
66	Kuen Lun No. 1 ..	24306	2	35 47 48	81 8 42	Kuen Lun
67	XXVI	24299	1	28 23 30	85 7 45	Nepal Himalaya
68	Haramosh	24270	3	35 50 29	74 53 52	Kailas
69	Sad Ishtagh ..	24171	4	36 32 54	72 6 54	Hindu Kush
70	XLVIII	24150	7	28 43 54	83 12 43	Nepal Himalaya
71	Kunjut No. 3 ..	24090	2	36 19 3	75 2 11	Karakoram
72	A satellite of Kinchin-junga	24089	5	27 47 15	88 11 55	Nepal Himalaya
73	Hunza-Kunji IV ..	24044	1	36 24 10	74 41 43	Karakoram
74	Chamlang	24012	2	27 46 31	86 58 56	Nepal Himalaya
75	Kabru	24002	2	27 36 30	88 6 50	Nepal Himalaya

The names adopted for the peaks are those most commonly employed by geographers. In a later section of this paper is given a list of alternative names and symbols, which have been applied to the high peaks at different times : in the same place are discussed a few geographical names that are giving rise to controversy and confusion.

Explanation of the tables.

* The values of longitude are based on the determination of the difference between Greenwich and Madras made in 1894-96, and are not those hitherto accepted by the Survey of India.

† The position of this peak is doubtful.

A column has been included in tables I to V showing the number of stations from which the height of each peak has been observed. For the attainment of accuracy it is more profitable to observe a peak from different places and distances than to multiply observations from any one station; and the number of observing stations is an indication of the trustworthiness of the resulting value of altitude. The accuracy of the adopted values of height is discussed hereafter, and numerical estimates of the magnitudes of the errors that may exist are formed.

The latitude and longitude of each peak have been given in the tables, so that its position on the charts may be ascertained. In the drainage charts XXIV to XXXIV (appended to Part III) these positions have been marked exactly: but in charts I to V the scale is so small that in crowded clusters there has not been always room to mark the precise position of each peak; a few of the symbols overlapped, and had to be slightly displaced in order to make room for others.

It will be noticed that every peak of chart I is shown by a larger and larger circle on each of the successive charts II to V; the reason for this increase is that at the level of 28000 feet Kinchinjunga, for example, is in nature hardly more than a point, but at 27000 feet the contour round Kinchinjunga encloses an *area*; and at 24000 feet a horizontal section taken through the Kinchinjunga pyramid would show that a *considerable* area of the earth's surface had attained that elevation.*

In the last column of each table is given the range on which each peak is situated, the great Himalaya range being divided into four sections:—

- (i) the Punjab Himalaya from the Indus to the Sutlej;
- (ii) the Kumaun Himalaya from the Sutlej to the Kali;
- (iii) the Nepal Himalaya from the Kali to the Tista;
- (iv) the Assam Himalaya from the Tista to the Brahmaputra.†

The relative positions of the ranges mentioned in the tables are shown on the range chart which serves as a frontispiece.

In table VI are given the details of a few well-known peaks, which are *less* than 24000 feet in height. This table unlike the preceding does not contain the names of all peaks above a certain height, and is not therefore a continuation of table V. Peaks have been omitted which exceed in height many of those of table VI; to give complete lists of all known peaks would be to convert this paper into a numerical catalogue.

A great many of the peaks of table VI are visible from Mussooree and Landour, and their outlines are shown in chart VIII.‡ The panorama of chart VIII is continuous from left to right: it has been drawn in three sections that it might be made to fit the size of this paper. The reference letters A and B have been added to indicate continuity.

* On chart V peaks of the fifth magnitude have been drawn as points, those of the fourth magnitude have been given a diameter of 6 miles, those of the third a diameter of 12 miles, those of the second a diameter of 18 miles, and those of the first a diameter of 24 miles.

† The Punjab and Kumaun Himalaya have been for the most part surveyed; the peaks of the Nepal Himalaya have been observed from long distances and the rivers and roads explored: the Assam Himalaya form still a *terra incognita*, although many of the peaks have been well observed from the south.

‡ This chart was copied from the panorama drawn by Col. St. G. C. Gore, C.S.I., R.E., in 1887.

TABLE VI.—Some well-known peaks the heights of which are less than 24000 feet.

Reference number of Peak.	Name in common use.	Height.	Number of stations from which the height was observed.	Latitude.	Longitude.*	Mountain range.
		<i>feet</i>		° ' "	° ' "	
76	Api ..	23399	3	30 0 22	80 55 57	Nepal Himalaya
77	Badrinath ..	23190	5	30 44 16	79 16 52	Kumaun Himalaya
78	Bandarpunch ..	20720	5	31 0 12	78 33 17	Kumaun Himalaya
79	Chumalhari ..	23930	2	27 49 39	89 16 15	Assam Himalaya
80	Chumunko ..	17310	4	27 27 31	88 47 12	Nepal Himalaya
81	Dayabhang ..	23750	2	28 15 22	85 31 9	Nepal Himalaya
82	Deotibba ..	20410	5	32 12 51	77 23 54	Punjab Himalaya
83	Dubunni ..	20154	1	35 57 23	74 38 5	Kailas
84	Dunagiri ..	23184	4	30 30 57	79 52 4	Kumaun Himalaya
85	Gangotri † ..	21700	3	30 52 58	78 52 14	Kumaun Himalaya
86	Gardhar ..	21140	1	32 55 7	76 42 48	Punjab Himalaya
87	Gaurisankar ‡ ..	23440	6	27 57 52	86 20 16	Nepal Himalaya
88	Jaonli § ..	21760	1	30 51 17	78 51 25	Kumaun Himalaya
89	Jibjibia East } ¶	21839	2	28 7 41	85 52 16	Nepal Himalaya
90	Jibjibia West } ¶	22876	2	28 10 25	85 46 51	Nepal Himalaya
91	Kailas ..	22028	2	31 4 2	81 18 50	Kailas
92	Kaufmann ..	23000	..	39 18 20	72 50 3	Trans Alai
93	Kedarnath ..	22770	6	30 47 53	79 4 7	Kumaun Himalaya
94	Kharchakund ..	21695	1	30 46 46	79 7 47	Kumaun Himalaya
95	Leo Pargial N. } ¶	22210	2	31 54 8	78 44 39	Zaskar
96	Leo Pargial S. } ¶	22170	2	31 53 5	78 44 5	Zaskar
97	Lunkho ..	22641	2	36 46 36	72 26 16	Hindu Kush
98	Mer or Kana || ..	23250	2	34 0 48	76 3 22	Punjab Himalaya
99	Nampa ..	22162	4	30 0 37	81 0 3	Nepal Himalaya
100	Nandakna ..	20700	2	30 20 56	79 43 9	Kumaun Himalaya
101	Nandakot ..	22510	3	30 16 51	80 4 11	Kumaun Himalaya
102	Narsing ..	19130	4	27 30 40	88 17 2	Nepal Himalaya
103	Nilakanta ..	21640	3	30 43 52	79 24 28	Kumaun Himalaya
104	Panch Chulhi ..	22650	3	30 12 51	80 25 41	Kumaun Himalaya
105	Pandim ..	22010	8	27 34 38	88 13 10	Nepal Himalaya
106	Pauhunri ..	23180	2	27 56 56	88 50 39	Nepal Himalaya
107	Sargaroin ..	20370	2	31 6 8	78 30 4	Kumaun Himalaya
108	Ser or Nana ** ..	23410	6	33 58 56	76 1 31	Punjab Himalaya
109	Simvo ..	22360	2	27 40 44	88 14 38	Nepal Himalaya
110	Srikanta ..	20120	4	30 57 25	78 48 22	Kumaun Himalaya
111	Tengri Khan ..	23600	..	42 24 10	80 16 43	Tian Shan
112	Tharlasagar ..	22610	2	30 51 41	78 59 45	Kumaun Himalaya
113	Trisul East ..	22320	4	30 16 14	79 52 24	Kumaun Himalaya
114	Trisul West ..	23360	7	30 18 43	79 46 40	Kumaun Himalaya

*The values of longitude are based on the determination of the difference between Greenwich and Madras made in 1894-96, and are not those hitherto accepted by the Survey of India.

† The twin of Jaonli.

‡ Double-peaked.

§ The twin of Gangotri.

¶ Twins.

|| The twin of Ser.

** The twin of Mer.

2

NOTES ON CERTAIN OF THE GREAT PEAKS.

MOUNT EVEREST.

The elevation of Mount Everest was first observed in 1849, but its height was not computed till 1852. Though half a century has elapsed since its discovery and the mountains of Asia have been continually explored in the interval, no second peak of 29000 feet has been found. There is but little probability now of a higher peak than Mount Everest being discovered and even the prospect of finding new peaks of 27000 or 26000 feet is becoming remote.

Some geographers have held that peaks higher than Mount Everest were standing behind it to the north, but their opinion was not founded on trustworthy observations, and when Major Ryder traversed Tibet along the Brahmaputra in 1904 he passed 80 miles north of Mount Everest and found no peak approaching it in height.

Three panoramas showing the outline of Mount Everest are included in chart vi.*

Owing to the objections of the Nepalese Government Mount Everest cannot be approached by surveyors from the side of India within 80 miles, and the trigonometrical observations that have been made of the Everest-Makalu group of peaks have been carried out under great disadvantages. The following description of Mount Everest is taken from a report by Colonel Tanner:†

“The outline of Everest is rather tame than otherwise; it is fairly sharp and has a long snowy slope on its north-east flank, the south-east being precipitous. Peaks of 22000 feet and thereabouts encircle its southern base, and below them are seen many outlines of dark mountain masses which are without snow.

“From due south, near the Kosi river in the Bhagalpur district, Everest is by no means a marked feature in the landscape; its southern face has but 190 feet of snow, below which the mountain falls for 4000 to 5000 feet in a series of crags of very dark-coloured rock, only here and there dashed and streaked with snow, below which are snow fields and broken masses of rock intermingled with snow and névé. When the atmosphere is not very transparent the sharp tip is seen as a mere floating white speck, the rock below it being almost exactly of the colour of the sky and therefore invisible.

“The southern face of Everest from a near point of view is doubtless wild, and its cliffs must be very lofty, but the great distance from which it is viewed renders this aspect of the mountain uninteresting. In fact, from the south, Everest has all the appearance of a very moderate hill, not in the least imposing and hardly picturesque. It is interesting only because by trigonometrical operations its summit has been found to rise up further from the general level of the earth's surface than that of any other point.”

* The panoramas from Mahadeo Pokra and Kaulia were drawn by Captain H. Wood, R.E., in 1903: those from Darjeeling and Sandakphu by Captain Harman, R.E., in 1882. Major Ryder's description of Mount Everest as seen from Tibet will be found in the *Geographical Journal*, Vol. XXVI. “It stands alone,” he wrote, “in magnificent solitude.” There is no doubt, whatever, that the peak observed by Ryder from Tibet was the same peak as had been fixed by the G. T. Survey from Bengal.

† *General Report, Survey of India*, 1883-84.

PEAK K².

The great altitude of peak K² was first discovered in 1858 by trigonometrical observations. "It was across the plains of Deosai," wrote Colonel Montgomerie, "from Haramukh that I took the first observation to peak K² at a distance of 137 miles."

K² is described by Colonel Godwin-Austen as follows: "K² is a conical mass with sides too steep to allow the snow to rest on them long: it lies therefore only in large patches and stripes on the fissured surface."

Sir Martin Conway writes that K² has a double summit, which he has seen on several occasions. Colonel Godwin-Austen, however, believes it to be single-peaked.*

KINCHINJUNGA.

K² has always been supposed to be the second highest mountain on the earth, but its height does not differ much from that of Kinchinjunga, and we cannot yet state with certainty which is the higher of the two.†

The following extract is from Colonel Tanner's report for 1883-84:—

"Kinchinjunga is a better known mountain than any in the Himalaya, and it is perhaps, with one exception, the grandest in the whole range. It is regarded by the permanent residents of Darjeeling with admiration that never palls, and although it is constantly, in clear weather, a prominent object in their front, the beholder is never wearied of studying the great snow slopes and ice fields which cover its sides.

"The aspect of the mountain has many phases which constantly alter its appearance from day to day. It is seen to best advantage when its base is veiled in a delicate curtain of clouds, so that the imagination is allowed to magnify the part which is hidden from view.

"From Darjeeling and from Sandakphu Kabru‡ appears as a straight-topped and uninteresting ridge of snow, standing slightly away from the central peaks of Kinchinjunga, but at a distance of 100 miles from points in the Purnea district of Bengal a telescope reveals the fact that the face of Kabru presented towards Darjeeling is only one side of a huge snow-clad tableland (24000 feet), quite smooth at the top with a very slight slope down to the westward. Kabru is connected with the second highest peak of Kinchinjunga (27803 feet) by a ridge, the very lowest depression of which has an altitude of 22100 feet."

In 1883 Mr. W. W. Graham claimed to have climbed Kabru, but his claim has been disputed by many authorities, though recognised by others. Colonel Tanner thought that Graham had mistaken a lower peak for Kabru.

Although the snow-line in Sikkim is lower than in the Western Himalaya and Karakoram, there are more naked spots on the slopes of Kinchinjunga than at similar altitudes on K² and Nanga Parbat.

The outline of Kinchinjunga as seen from Darjeeling is shown in chart vi.

* *Geographical Journal*, Vol. III, pages 431 and 527.

† *Survey of India, Professional Paper No. 9, 1905. Annual Report of the Board of Scientific Advice for India. 1905-06.*

‡ *Vide table v.*

MAKALU.

A rock basin filled with glacier-ice is situated near the summit of Makalu and gives a striking appearance to the peak.

In 1853 before trigonometrical observations had been taken Captain Sherwill wrote of Makalu :—

“ One mountain in the Nepal range is a most remarkable object, both for its curious shape and for its immense height : its name none of my party knew, nor have I yet succeeded in obtaining the name. The peak is a hollow crater-like mountain probably 27000 feet in height with a long table-mountain attached to it, both covered with glaciers.” *

In 1884 Colonel Tanner wrote :—

“ With the exception of the Kinchinjunga peak, Makalu is the finest yet fixed in the eastern Himalaya. It stands apart from the Everest group and exposes a great mass of snow towards the Sandakphu ridge. From the south, in the plains of Bhagalpur and Purnea, it is the most striking object in the panorama of snow. It has a remarkable cup or hollow, which extends for about one-third down its slope, by which it may be recognised. When examined with a high-power telescope great masses of glacier-ice may be seen finding their way over the edge of the cup. This ice has been collected round the sides of the amphitheatre-like hollow. The upper half of the mountain is composed of a very light coloured rock, but the southern spur is dark like the cliffs, which are seen on the southern face of Everest. The white colour of the rock lends it a softness, which is absent in the appearance of its higher neighbour. The southern and eastern faces are fully snow-clad, but on the west are much bare rock and extensive streaks and patches which are too steep to retain snow on their slopes. No northern spur of this mountain has been seen, but I have traced one of about 19000 feet elevation towards the east, until it dips into the Arun valley. To the south two picturesque branches fully clad with snow are thrown off, but I cannot say that I have detected any saddle or ridge connecting Makalu with Everest.”

Makalu is remarkable for its sharp-edged buttresses, one of which is a magnificent specimen of the spiral type. These spiral buttresses conveying the idea of torsion are to be seen in all parts of the Himalaya: Rakaposhi in Hunza has one, Simvo (22360 feet) in Sikkim has one, and to residents of Mussooree the curvature of the eastern buttress of Banog (7433 feet), a small peak in the vicinity, is a permanent object of beauty.

Hermann de Schlagintweit, when observing Makalu from Phallut in 1855, mistook it for Mount Everest, † and the same mistake has been made by other travellers. Sandakphu, situated 38 miles from Darjeeling and on the Singalila ridge, commands a fine view of Makalu: from there the peak is 78 miles distant and is a more striking feature than Mount Everest, which stands 12 miles in rear.

The outlines of Makalu and Everest as seen from Sandakphu are shown in chart vi.

PEAK T⁴⁵.

T⁴⁵ is a high peak of the Nepal Himalaya seventeen miles north-west of Mount Everest. It appears to have been missed by the observers of the Great Trigonometrical Survey in 1850, but was observed by Tanner in 1884 from three different stations. Tanner recorded that it had a rounded top.

* *Journal, Asiatic Society of Bengal*, Vol. XXII, 1853.

† *Vide Nature*, No. 1828, Vol. 71 ; Nov. 10, 1904 ; page 3.

NANGA PARBAT.

Nanga Parbat is the most isolated and perhaps the most imposing of all the peaks of Asia. With the exception of subordinate pinnacles rising from its own buttresses, no peak within 60 miles of Nanga Parbat attains an altitude of more than 17000 feet. Throughout a circle of 120 miles diameter Nanga Parbat surpasses all other summits by more than 9000 feet. Its upper 5000 feet are precipitous.

"Perhaps in describing mountains," wrote John Ruskin in *Modern Painters*, "with any effort to give some idea of their sublime forms, no expression comes oftener to the lips than the word 'peak,' and yet it is curious, how rarely even among the grandest ranges an instance can be found of a mountain ascertainably peaked in the true sense of the word,—pointed at the top and sloping steeply on all sides."

A traveller in the Himalaya, who has studied the writings of Ruskin, must constantly be impressed with the accuracy of his observations. How often do we see a high peak towering above us, only to find on ascending that it is but an obtuse angle in the slope of a buttress? How often is a needle discovered to be but the end of a sharp-edged ridge? Many of the peaks of tables I to VI, though they may form good definite points for surveyors, fail to satisfy Ruskin's definition.

But no one can question the claims of Nanga Parbat: its form and its solitude render it a "peak," however we define the word.

"Nanga Parbat's summit," wrote Colonel Tanner, "is 26620 feet above the sea, and its base stands on the left side of the Indus valley, which at that point is but 3500 feet: it therefore exposes 23120 feet of its side to an observer, who, standing as near as he may dare to the edge of perhaps the most lofty cliff in the world with the Indus valley 12000 feet below him, may regard at the distance of less than 40 miles the unparalleled view presented by the vast snow fields, glaciers, and crags of this King of Mountains. It is a scene that is not grasped or taken in at once, but after a while the stupendous grandeur of the view is appreciated. It is quite overwhelming in its magnitude; it is in fact one of the grandest spectacles that nature offers to the gaze of man."

Until the height of Nanga Parbat had been determined by the Great Trigonometrical Survey, it was given on maps as 19000 feet. An error amounting to 7600 feet in defect in the case of a solitary impressive peak shows how worthless are eye-estimations of height.*

MASHERBRUM OR K¹.

The Masherbrum peaks are two well-defined points connected by a saddle: they are 1000 feet apart and differ by 50 feet in altitude.

RAKAPOSHI.

Of Rakaposhi Colonel Tanner wrote as follows: "The mighty Rakaposhi or devil's tail of Gilgit, rising from ground which is 7000 or 8000 feet above the sea, may be viewed from a distance of less than 40 miles by any one bold enough to

* *Annual Report of the Board of Scientific Advice for India, 1904-05.*

“make the journey over the dreadful Saichar pass to Chaprot and thence up to the grassy downs above that place, and the splendid appearance of Rakaposhi will be a sufficient reward for his trouble. It is a vast clean-cut brilliant snow needle, absolutely sharp, rising thousands of feet above a mass of broken snows, below which are the wild precipices and serrated ridges peculiar to the Gilgit mountains.”*

KAMET.

Kamet is a conspicuous landmark from all the elevated parts of Nari Khorsam; it is also visible from Almora on the Indian side, “where, however, its appearance is so modest that, till 1849, it remained unnoticed and unmeasured, though but 250 feet lower than the King of the western Himalaya, Nanda Devi.”†

Kamet stands behind the Great Himalaya range and its height was first determined by Richard Strachey. Its outline as seen from Cheena is shown in chart VII.

TIRICH MIR.

Snow forms a thick unbroken covering over Tirich Mir, and gives to the peak a rounded rather than a pointed top. The patches of naked rock, that are to be seen on all the slopes of the great peaks of the Himalaya, are absent from the flanks of Tirich Mir.

GURLA MANDHATA.

Dr. T. G. Longstaff made an attempt to climb Gurla Mandhata in 1905, and attained a great height, possibly exceeding 23000 feet, but failed to reach the summit.‡

In 1878 Mr. Ryall wrote of this mountain as follows:—

“Gurla Mandhata, which is 3500 feet higher than Kailas, is held in comparatively little religious esteem among the Buddhists and Hindus. Owing to its immense bulk and height—3000 feet above any peak within a radius of 40 miles—it is perhaps the most impressive sight in the whole of the Himalaya, the celebrated mountain of Nanga Parbat alone excepted.”§

KUNGUR AND MUZTAGH ATA.

The peaks of Kungur and Muztagh Ata have been mistaken for one another by many travellers. Captain Trotter was the first trigonometrical observer of Kungur, and from the plains of Kashgar he determined its height at 25350 feet; he named the peak “Tagharma.”

Muztagh Ata is 26 miles south of Kungur and is not visible from Kashgar. Travellers have frequently thought that they have seen Muztagh Ata from Kashgar: but they have been misled by the natives, who believe Kungur and Muztagh Ata to be one summit. Colonel Wahab called the Muztagh Ata peak “Tagharma.”

* *General Report, Survey of India, 1883-84.*

† *Journal, Royal Geographical Society, Vol. XXIII, 1853*,—Captain H. Strachey *On the Physical Geography of Western Tibet.*

Henry Strachey wrote before the height of Nanga Parbat had been ascertained. Montgomerie was right when he said that Nanga Parbat was as much the King of the western Himalaya as Mount Everest was of the eastern. Nanga Devi is the highest point of the Kumaun or central section of the Himalaya, but does not compete with Nanga Parbat. d

‡ Charles A. Sherring: *Western Tibet and the British Borderland*; also *Alpine Journal*, August 1906.

§ *General Report, Survey of India, 1877-78.*

The fact that both Kungur and Muztagh Ata were named "Tagharma" by surveyors has tended to increase the confusion. The name Tagharma is given by natives to the peak of Muztagh Ata because it towers above the town of Tagharma in the Sarikol valley, and Wahab was correct in his application of the name. But Trotter made a mistake in adopting the assumption of Kashgarians, that the great snow peak they see to the south-west is the same peak as seen from Tagharma.

There has not only been a confusion of names, but differences of opinion have existed as to which of the two peaks is the higher, Kungur, the northern, or Muztagh Ata, the southern. The values of height entered in tables iv and v are those derived from the data at the disposal of the Survey of India, but it has to be acknowledged that the observations are less reliable than those of the Himalayan and Karakoram peaks. In the case of observations taken to peaks from stations in India the height of the place of observation is accurately known, but the same cannot be said of the points from which Kungur and Muztagh Ata were observed. Though all our information goes to show that Kungur is higher than Muztagh Ata, by about 758 feet, the great weight of Sven Hedin's authority is on the side of Muztagh Ata. "Muztagh Ata," he writes, "the loftiest mountain of the Pamirs and one of the loftiest mountains in the world, towers up to the height of 25600 feet, and like a mighty bastion overlooks the barren wastes of Central Asia. It is the culminating point in a meridional chain. The unchallenged pre-eminence of Muztagh Ata over the peaks which cluster around it is proved by its name, which means the Father of the Ice Mountains."*

Sven Hedin made three attempts to climb Muztagh Ata, but was not successful.

Lord Curzon describing the peaks of Kungur and Muztagh Ata wrote: "The second and southerly peak, which from Sarikol obscures the first, is the real Muztagh Ata, the height of which is probably a little less than its nameless brother, being calculated at about 25000 feet, but which is a far finer mountain since it is conical and comparatively isolated, whereas the more northerly mountain is the highest crest of an extended ridge."†

API AND NAMPA.

The remarkable group of peaks in western Nepal, of which Api and Nampa (table vi) are the principals, has been imperfectly studied. During the observations of the Great Trigonometrical Survey the cluster was continually obscured by haze, and only one peak was observed. A crowded cluster that is seldom visible in winter, except perhaps on certain days for a few minutes at sunrise, and that is completely hidden by clouds in summer, presents great difficulties to the observer.

* Sven Hedin: *Through Asia*, page 221. It is perhaps unfair to give this quotation, for when Sven Hedin wrote he may have been unaware that there was any question at issue. As, however, his book has had a wide circulation, we think it right to point out that our results do not confirm Sven Hedin's opinions.

† *Geographical Journal*, Vol VIII, 1896.

If he succeeds in observing the directions of six peaks from both an eastern and a western station, each of the six rays from his eastern station cuts each of the six from his western, and thirty-six points of intersection are given within a small area. If the peaks have been observed from a third station also, difficulties disappear, but when they have been seen from two only, the true points of intersection have to be determined from a study of the several values of height.

Many map-makers have confused the peaks of Api and Nampa, but their heights differ by 1237 feet. Colonel Tanner's observations show that Api is a double peak, the higher point of which (23399 feet) stands half a mile north-east of the lower (23287 feet).

The observations of Colonel Tanner's assistant Rinzin show another peak called Ningru (23143 feet) rising between the two peaks of Api. It is extremely unlikely that the name of Ningru has been attached by natives to this close companion of Api, and it is more reasonable to assume that Api and Ningru are alternative names employed, perhaps in different localities, for the same snowy mass.

According to the observations of Tanner's assistants Nampa is a double peak also, the two summits being 2 miles apart. The higher Nampa is 4 miles east of the higher Api.

The only peak of this cluster observed by the Great Trigonometrical Survey was peak LIII: its position was fixed, but not its height; its position, which was determined from two stations of observation only, is $1\frac{1}{2}$ miles south-south-west of Api (23399 feet).

The *Encyclopædia Britannica* shows a peak of this cluster as Mount Humla (24702 feet), but, incomplete as the trigonometrical observations of the Api-Nampa group have been, they are sufficient to indicate that no peak exceeding 24000 feet stands in this region.

The outline of Api is shown in chart VII.

"The purity of its unbroken snow and boldness of its outline," wrote Colonel Tanner of the Api peak (23399 feet), "I have nowhere seen equalled. The ridges that connect the highest with the lower points of Api are perfectly sharp and decided, and for several thousands of feet there is scarcely a splinter of naked rock to mar the unrivalled whiteness of its slopes. The base and lower spurs of Api touch the Kali valley and are clothed with variegated masses of birch and pine except in those places where constantly recurring avalanches admit only of the growth of short grass." *

CHUMALHARI.

The peaks of Chola (17310 feet) and of Chumalhari (23930 feet) appear from Senchal near Darjeeling to be in almost the same direction, the distance of Chumalhari being double that of Chola.†

* *General Report, Survey of India, 1884-85.*

† Chola is called Chumunko in table VI and Gaoring on North-Eastern Trans-Frontier Sheet No. 7 N. W.

A letter written by Dr. Campbell from Darjeeling in 1848 is interesting as showing how mistaken the natives of the mountains may be. His letter runs :—

“When Colonel Waugh left this place in November last, after having satisfied himself of the position of Chumalhari by observations from Tonglu and Senchal, I took some Lepchas and Bhotiahs, who had travelled into Tibet by the Phari route, with me to the top of Senchal, to point out Chumalhari to them, as they were positive in stating their belief that it was not visible from any part of this neighbourhood. When I said ‘There is Chumalhari,’ the whole party exclaimed ‘No, it is Chola, and not Chumalhari.’ I took pains to ascertain the reasons of their dissent, and afterwards wrote an epitome to Colonel Waugh, who said, as far as I recollect, ‘You may rely upon it, that I shall not finally decide the point until you are satisfied that I am right.’ ”*

Colonel Waugh eventually proved that the peak observed from Senchal was Chumalhari.

KAILAS.

“It is solely due,” wrote Mr. E. C. Ryall, “to the circumstance of its shape resembling that of a Hindu temple that Kailas is vested with a sacred character.”†

SER AND MER.

Ser and Mer, known also as the Nun Kun peaks, are remarkable twin giants (*vide* table VI), rising from a region of perpetual snow: they are the highest points of the Punjab Himalaya between the Sutlej and Nanga Parbat. Ser is white and Mer is dark, being too precipitous on the side of India to retain much snow.

Ser is $2\frac{1}{2}$ miles south-west of Mer: a third peak (22810 feet) stands $1\frac{3}{4}$ miles east-north-east of Mer, and there is a fourth peak (22310 feet) two miles east of Mer. The positions and heights of these four peaks were well determined. The account given in the *Geographical Journal* ‡ of the Bullock-Workman expedition refers to a third peak of the group, exceeding 23000 feet. No third peak however of 23000 feet was observed by the Trigonometrical Survey. The peak climbed by Mrs. Bullock-Workman was Mer.

TENGRI KHAN.

Tengri Khan is the highest peak of the Tian Shan and the highest point of Asia north of latitude 39° . In his *Central Tian-Shan Mountains* Merzbacher describes the isolated eminence of Tengri Khan as “without example in mountain systems of like extent.” “The mountain,” he says, “has no rival and overtops the highest summits of all the neighbouring ranges by over 3000 feet.”

* *Journal, Asiatic Society of Bengal*, Vol. XVII.

† *General Report, Survey of India*, 1877-78.

‡ November, 1906.

3

ON THE NAMES OF CERTAIN PEAKS.

It is not often that a surveyor can discover a native name for a peak : natives of the hills do not give names even to remarkable peaks.

Absence of Native names.

"To my disappointment," wrote Sir Joseph Hooker, "I found that neither priest nor people knew the name of a single snowy mountain." *

Of the 75 great peaks included in tables I to V but 19 have native names. If we take into account the lower peaks, we find that there are many thousands of prominent but unnamed summits in Asia, and the problem of nomenclature has to be considered. It would be a mistake to attempt to attach an actual name to every peak. Astronomers do not name the stars : in olden times they grouped them in constellations, and they now number them according to right ascension. Colonel Montgomerie endeavoured to introduce for peaks a method resembling that of constellations, and he named the whole Karakoram region K, and its peaks K¹, K², K³, etc.†

This system would have answered well, but Colonel Tanner and subsequent surveyors have departed from it, and have adopted the plan of designating each peak by the initial letter of the observer : Tanner called, for instance, the peaks he had observed himself T⁴⁵, T⁵⁷, etc. The employment of observer's initials has led to confusion : two and more observers have had the same initial, and the same symbol has thus become attached to different peaks. Moreover the designations given under Tanner's system furnish no clue as to the region in which the peaks are situated.

The nomenclature of a mountain region should not be forced : it should grow spontaneously, and we should never invent a name until its absence has become inconvenient. We cannot do better for Tibet and Turkistan than extend the simple system introduced by Montgomerie for the Karakoram : his method of constellations is more suitable for the peaks of Asia than a long series of successive numbers from west to east would be. We need not design constellations to include one whole range, and we need not follow the astronomical plan of drawing animals and heroes ; we can have rectangular constellations enclosed by meridians and parallels.

Peaks however possess in their heights an attribute which stars lack, and there is no more useful means of distinguishing peaks than by their heights. If we are dealing with a complex cluster of peaks, it is simpler to indicate the several members by their heights than to confer on them separate names. In discussions of the peaks of Asia heights must be accepted to a certain extent as substitutes for names.

Peaks can be distinguished by their heights.

* *Himalayan Journals*, Vol. I, page 370.

† A note on the name Karakoram is given in Section 16 of Part II of this paper.

There will be no difficulty in preventing the same value of height being given to two or more peaks. The heights of peaks are not known within 10 feet, and it is thus possible to adjust the height of a newly measured peak by one or two feet, if it happens to have been given the same height as one previously determined.

If the heights of peaks come to be recognised as a means of identification, they should not be altered whenever any trifling improvement in the value is believed possible. The height of Mount Everest was originally determined at 29002 feet, and this value should still be retained: a few years ago its height on maps was reduced to 28995 feet because the stations from which it had been observed were found to be 7 feet lower than had originally been assumed: subsequently for a similar reason the height was altered to 28994 feet. But these alterations were not justifiable, and only tended to produce confusion. It is known that the height 29002 feet is, if anything, too low, but it is not desirable to alter it, because the value 29002 is a clear indication of the particular peak denoted.

We are not proposing now to bind our successors for all time to adhere to the present values of heights: periodical revisions of values can be carried out every twenty or fifty years, if fresh information has been accumulated in the interim. All that is proposed now is that the heights allotted to the peaks in tables I to VI be accepted until proof is forthcoming of serious error, and that no small or frequent changes in value, such as have constantly led to confusion in the past, be made in the future.

In the following table are shown the various names and symbols that have been applied to the several peaks of tables I to VI at different times by surveyors and travellers:—

TABLE VII.—Names and Symbols which have been used by different authorities to denote the peaks of tables I to VI.

No. of Peak.	Name adopted in this paper.	Name employed in the records of the Great Trigonometrical Survey.	Names employed by observers in the field.	Alternative names occasionally used.
1	Mount Everest	XV		See below.
2	K ²	Karakoram No. 13*	K ² by <i>Montgomerie</i>	Mount Godwin-Austen (see below), Dapsang by <i>Schlagintweit</i> in 1856.
3	Kinchinjunga I	IX		..
4	Kinchinjunga II	VIII		..
5	Makalu	XIII		..
6	T ⁴⁵		T ⁴⁵ or T45 by <i>Tanner</i>	..
7	Dhaulagiri	XLII		..
8	XXX	XXX		..
9	Nanga Parbat I	Nanga Parbat		Dayamur, Dairmal, Deo Mir.
10	XXXIX	XXXIX		..

* The name *Karakoram* was spelt *Karakuram* by *Montgomerie*, and is consequently so spelt in many of the records of the Great Trigonometrical Survey. But the form *Karakoram* is now held to be correct.

TABLE VII.—Names and Symbols which have been used by different authorities to denote the peaks of tables I to VI—*continued*.

No. of Peak.	Name adopted in this paper.	Name employed in the records of the Great Trigonometrical Survey.	Names employed by observers in the field.	Alternative names occasionally used.
11	K ⁵ or Gasherbrum I	Karakuram No. 9	K ⁵	..
12	K ⁴ or Gasherbrum II	Karakuram No. 10 (Gasherbrum)	K ⁴	..
13	Gosainthan	XXIII		..
14	K ^{3a} or Gasherbrum III	Karakuram No. 11	K ^{3a}	..
15	XXXIV	XXXIV		..
16	K ³ or Gasherbrum IV	Karakuram No. 12	K ³	..
17	T ⁵⁷		T ⁵⁷ by Tanner	..
18	B ⁷⁵²		B ⁷⁵² by Barckley	Fishback by Tanner
19	XXVIII	XXVIII.		..
20	Kambachen		North of Kanchin by Robert, S. E. 13 by Tanner	..
21	XXIX	XXIX		..
22	Masherbrum East	Masherbrum E.	K ¹ East	..
23	Nanda Devi	LVIII		A No. 2 by Hodgson and Herbert : XIV by Webb
24	Masherbrum West	Masherbrum W.	K ¹ West	..
25	Nanga Parbat II		Great Range No. 30	..
26	LIX	LIX		..
27	Rakaposhi	Rakipushi	U ⁴⁹	..
28	Kunjut No. 1	Kunjut No. 1.	Trans-Indus No. 4	..
29	Kamet	LXVII	Kamet by Richard Strachey, Kangmen by Ryder	Ibi Gamin by Schlagintweit
30	T ⁴²		T ⁴² by Tanner	..
31	XLIII	XLIII		..
32	Tirich Mir I		DsEb by Tanner	..
33	N ⁵³		N ⁵³ by Robert	..
34	K ¹⁰	Karakuram No. 3	K ¹⁰	..
35	Hunza-Kunji I	Kunji No. 8	T ⁹⁵ by Tanner	..
36	Gurla Mandhata		Memonamnyimri by Ryder	Nimo Namling by Tanner
37	Jano	XI		Jannu
38	K ¹¹	Karakuram No. 4	K ¹¹	..
39	XLIV	XLIV		..
40	B ⁷⁶³		B ⁷⁶³ by Barckley	..
41	Shyok Nubra Watershed No. 5.	Sheok-Nubra Watershed No. 5.	K ²²	..
42	Kungur I		Peak 2 of Camp 9 by Ram Singh	Tagharma by Trotter, Mount Dufferin by Ney Elias
43	B ⁵⁰⁴		B ⁵⁰⁴ by Barckley	..
44	Hunza-Kunji II		Highest Peak South by Holdich	..
45	Karakoram No. 8	Karakuram No. 8	K ⁶	Chogolisa by Norman Collie

TABLE VII.—Names and Symbols which have been used by different authorities to denote the peaks of tables I to VI—*continued*.

No. of Peak.	Name adopted in this paper.	Name employed in the records of the Great Trigonometrical Survey.	Names employed by observers in the field.	Alternative names occasionally used.
46	XLVI	XLVI . . . .	. . . .	..
47	Hunza-Kunji III . . .	Hunza No. 2 . . .	U ⁹¹	..
48	Kungur II		Peak 3 of Camp 9 by <i>Ram Singh</i>	..
49	XLV	XLV . . . .	. . . .	..
50	XXXVI	XXXVI . . . .	. . . .	..
51	Kulha Kangri I . . .	Bhutan-Tibet range No. 2 Pk	. . . .	..
52	Karakoram No. 5 . . .	Karakoram No. 5 . .	K ²²	..
53	XXXV	XXXV . . . .	. . . .	..
54	Kulha Kangri II . . .	Bhutan-Tibet range No. 1 Pk		R ²²² by <i>Ryder</i>
55	Shyok Nubra Watershed No. 3	Sheok-Nubra Watershed No. 3	K ²⁴	..
56	Tirich Mir II		IGmi by <i>Tanner</i> . . .	Nushau No. 1
57	Shyok Nubra Watershed No. 4	Sheok-Nubra Watershed No. 4	K ²³	..
58	Kunjut No. 2	Kunjut No. 2 . . .	Trans-Indus No. 2 by <i>Montgomerie</i>	..
59	R ²⁶⁴		R ²⁶⁴ or R264 by <i>Ryder</i>	..
60	Indus-Nagar Watershed No. 2	Indus-Nagar Watershed No. 2	U ⁶⁷	..
61	LVII	LVII . . . .	. . . .	..
62	Muztagh Ata		Tagharma by <i>Wahab</i> .	..
63	K ¹²	Karakoram No. 4 . .	K ¹²	..
64	A satellite of Kinchinjunga		Centre of great broad peak	..
65	Tirich Mir III		IGmf by <i>Tanner</i> . . .	..
66	Kuen Lun No. 1 . . .		Peak 9, Camp 58 by <i>Ram Singh</i>	..
67	XXVI	XXVI . . . .	. . . .	..
68	Haramosh	Haramosh	B ¹⁴ U ⁶⁹	..
69	Sad Ishtragh		Dsb	..
70	XLVIII	XLVIII . . . .	. . . .	..
71	Kunjut No. 3	Kunjut No. 3 . . .	T ⁹⁷ by <i>Tanner</i> . . .	..
72	A satellite of Kinchinjunga		Centre of huge mass, North of Kinchinjunga	..
73	Hunza-Kunji IV . . .		CBu	Boyohaghurdonas
74	Chamlang	XIV . . . .	. . . .	..
75	Kabru	X . . . .	. . . .	..
76	Api			Ningru
77	Badrinath	LXIX	VIII by <i>Webb</i> . . .	..
78	Bandarpunch	LXXXVII		Jumnootri by <i>Gerard</i>
79	Chumalhari	1		Chola by <i>Dr. Campbell</i>
80	Chumunko	IV		L or Dayabang by <i>Col. Crawford</i>
81	Dayabhang	XXV		

TABLE VII.—Names and Symbols which have been used by different authorities to denote the peaks of tables I to VI—concluded.

No. of Peak.	Name adopted in this paper.	Name employed in the records of the Great Trigonometrical Survey.	Names employed by observers in the field.	Alternative names occasionally used.
82	Deotibba . . .	Deotibba . . .	. . . . .	..
83	Dubunni . . .	Dubunni . . .	. . . . .	..
84	Dunagiri . . .		<i>a²⁰ by Carter</i>	..
85	Gangotri . . .		Gangotri <i>α</i> S. P. <i>by Ryall</i>	..
86	Gardhar . . .	Gardhar . . .	. . . . .	..
87	Gaurisankar . . .	XX . . .	. . . . .	..
88	Jaonli . . .	LXXV . . .	. . . . .	..
89	Jibjibia East . . .	XXII . . .	. . . . .	..
90	Jibjibia West . . .	XXIV . . .	. . . . .	..
91	Kailas . . .	Kailas . . .		Kangrinpoche
92	Kaufmann . . .	. . . . .	. . . . .	..
93	Kedarnath . . .	LXXII . . .	III <i>by Webb</i>	Bharti Khunta
94	Kharchakund . . .		Kharcha Koond No. 2 S.P. <i>by Ryall</i>	..
95	Leo Pargial N. . . .	Leo Pargial N. . . .	. . . . .	..
96	Leo Pargial S. . . .	Leo Pargial S. . . .		—
97	Lunkho . . .		IGmp	..
98	Mer . . .	Mer or Kana . . .		Kana. Kun. Dam Huy. The Nun Kun peaks are Mer and Ser
99	Nampa . . .			Namju
100	Nandakna . . .	LXIV . . .	. . . . .	..
101	Nandakot . . .	LVI . . .	. . . . .	..
102	Narsing . . .	VI . . .	. . . . .	..
103	Nilakanta . . .	LXVIII . . .	IX (Nilakanta) <i>by Webb</i>	..
104	Panch Chulhi . . .	LIV . . .	XX <i>by Webb</i>	..
105	Pandim . . .	VII . . .	. . . . .	..
106	Pauhunri . . .	III . . .	Powhunri	Donkia <i>by Dr. Hooker</i>
107	Sargaroin . . .	LXXIX . . .	H. Left Peak <i>by Hodgson and Herbert</i>	..
108	Ser . . .	Ser or Nana . . .		Nana. Nun. Pajah Huy. The Nun Kun peaks are Mer and Ser
109	Simvo . . .		S 30	..
110	Srikanta . . .	LXXVI . . .	Bus peak <i>by Du Vernet, G</i> or Srikanta <i>by Hodgson and Herbert</i>	..
111	Tengri Khan . . .	. . . . .	. . . . .	..
112	Tharlasagar . . .	LXXIV . . .	M or Mont Moira <i>by Hodgson and Herbert, I by Webb</i>	..
113	Trisul East . . .	LX . . .	XIII (East Trisool) <i>by Webb</i>	..
114	Trisul West . . .	LXII . . .	A No. I <i>by Hodgson and Herbert, XII</i> (West Trisool) <i>by Webb</i>	..

In 1852 the chief computer of the Trigonometrical Survey informed the Superintendent, Sir Andrew Waugh, that a peak designated XV had been found from the computations to be higher than any other hitherto measured in the world. This peak was discovered by the computers to have been observed from six different stations: on no occasion had the observer suspected that he was viewing through his telescope the highest point of the earth.*

The Indian Survey had always adhered to the rule of assigning to every geographical feature its true local or native name, but here was a mountain, the highest in the world, without any local or native name that the surveyors were able to discover. The Surveyor General, Sir Andrew Waugh, decided to name the great snow-peak "Mont Everest" after his former chief, Sir George Everest, the celebrated geodesist.

Waugh wished to introduce the word "Mont" in preference to "Mount," but "Mont" never came into vogue. It seems to have been immediately replaced in common usage by "Mount," and for 50 years "Mount Everest" has been the name generally adopted throughout the world.

When Sir Andrew Waugh announced that the peak was to be named "Mont Everest," Mr. Hodgson, who had been political officer in Nepal, wrote many papers to show that Waugh had been mistaken, and that the mountain had a local name, viz., Devadhunga. But Mr. Hodgson mistook another peak for Mount Everest and it is probable that he never saw Mount Everest at all. All subsequent and recent information goes to show that there is no peak of the Himalaya called Devadhunga.†

In 1855 Hermann de Schlagintweit visited a hill in Nepal called Kaulia near Katmandu, and from it took observations to the snow peaks. He saw the mountain called Devadhunga by Hodgson, and he identified it as Mount Everest; he however repudiated Hodgson's name of Devadhunga and certified that the local native name for the peak was Gaurisankar. Many geographers accepting Schlagintweit's views have continued to this day to call the highest mountain in the world Gaurisankar: the Indian Survey however were unable to reconcile Schlagintweit's results with their own and declined to follow him. There is no doubt now that Schlagintweit was misled in his identification of Mount Everest. In 1903 Captain Wood, R.E., visited Kaulia by order of Lord Curzon: he found that Gaurisankar and Mount Everest were different peaks 36 miles apart, and that the peak called Devadhunga by Hodgson and Gaurisankar by Schlagintweit was a peak long known in the records of the Survey as peak XX (height 23440 feet).‡

In addition to his Kaulia observations, Schlagintweit observed at Phallut on the Singalila ridge, and from there he painted his now well-known picture of Mount

* *Nature*, Nos. 1828 and 1830, Vol. 71; Nov. 10 and 24, 1904.

† This name may possibly be a mythological term applied to the whole snowy range by the natives of a certain part of Nepal.

‡ See Wood's *Report on the Identification and Nomenclature of the Himalayan peaks as seen from Katmandu*, 1904; also his *Narrative Report*, 1903-04.

Everest: but unfortunately he fell again into error, for the mountain he painted is clearly Makalu and not Mount Everest.

Of recent years endeavours have been made to show that the Tibetans have a name for Mount Everest, namely, Jomokangkar or Jhomogangar or Chamokankar, but no reliable evidence has been produced. In 1904 the surveyors attached to the Tibet Frontier Mission made careful enquiries, but found no such name applied to the great Himalayan peak. On the other hand the explorer Kishen Singh found a mountain called Jhomogangar * in the interior of Tibet, 215 miles north-east of Mount Everest. This peak of Jhomogangar has been shown on maps of Tibet since 1872. Kishen Singh in his narrative describes his arrival at Dung Chaka (15700 feet) and then adds, "About 10 miles to the east there is a lofty snowy peak called Jhomogangar, somewhat of the same shape as the Kailas peak near Manasarowar: it is a noted object of worship, being considered as a female divinity."

After 50 years of controversy no true native name has been produced for Mount Everest: each of those suggested has in turn been shown to be inapplicable, and the evidence that no such name exists is overwhelming. In the meantime the name Mount Everest has been widely adopted, and it would be a mistake to go back upon it now. Personal names for geographical features are doubtless objectionable, but we must accept accomplished facts: geographical progress is retarded by unprofitable changes and by barren controversies over names.†

No native name for peak K² could be discovered by surveyors, and in 1856 it was designated K² by Montgomerie. The designation has been generally accepted, and will now, it is hoped, be retained in perpetuity.

The name of K².

When the final results of the Kashmir Survey were being prepared for publication, the numbering of the peaks of the Karakoram range was altered in order to produce continuity from west to east, and in some publications of the Great Trigonometrical Survey the peak K² is shown as Karakoram No. 13. This duplication of designations is now regretted, and the symbol K² will alone be used in future.

The height first given by the Survey to K² was 28278 feet; the value now accepted is 28250 feet.

Schlagintweit thought that the native name of peak K² was Dapsang: Sir Martin Conway gave it as Chiring:‡ and other travellers have reported it to be Chogo Ri.§

* Latitude 29°50' N.; Longitude 89°50' E. *Geographical Journal*, Volume XXV, p. 179.

† In connection with the subject of personal names Lieutenant Wood, R.N., is often quoted as having given the name of Victoria to the Lake of Sir-i-Kul in the Pamirs; it may therefore not be out of place to quote Wood's own words: "As I had the good fortune to be the first European who in later times had succeeded in reaching the sources of this river, and as, shortly before setting out on my journey, we had received the news of her gracious Majesty's accession to the throne, I was tempted to apply the name of Victoria to this, if I may so term it, newly re-discovered lake; but on considering that by thus introducing a new name, however honoured, into our maps a great confusion in Geography might arise I deemed it better to retain the name of Sir-i-Kul, the appellation given to it by our guides."

‡ *Proceedings, Royal Geographical Society*, Vol. XIV, p. 857, and *Geographical Journal*, Vol. I, p. 177.

§ Ri merely means "mountain."

None of these names is in common use by the natives, and nothing would be gained by the adoption of any one of them.

Sir M. Conway writes of the Chogo peak as being quite distinct from K², and Dr. Hunter Workman attaches the name of Chogo Ri on his map to a different peak from K². Professor Norman Collie gives the name Chogolisa to peak No. 45 of table iv.

In 1888 at a meeting of the Royal Geographical Society it was proposed by General Walker to give the name of Godwin-Austen to peak K² after the officer who first surveyed the Karakoram range and glaciers; the name Godwin-Austen is now applied to the peak by many map-makers, but it has not been accepted by the Surveyor General of India and has not been entered on the maps of the Government of India.

Of all the designations suggested for the supreme peak of the Karakoram that of K² has now the widest vogue, and it will be in the interests of uniformity, if this symbol be adopted henceforth to the exclusion of all others. The permanent adoption of the symbol K² will serve to record the interesting facts that a mountain exceeding 28000 feet in height had not been deemed worthy of a name, by the people living under its shadow, and that its pre-eminent altitude was unsuspected until it was brought to light by trigonometrical observations.

The name Kinchinjunga has been spelt in a variety of ways. Uniformity in spelling is of more importance to geographers than correctness. The correct forms are doubtless Kanchenjunga or Kanchendzonga, but the more familiar form of Kinchinjunga is that adopted by the new Imperial Gazetteer, and this, it is to be hoped, will now come into general use. In north-eastern Nepal Kinchinjunga is known as Kumbhkaran Langur.

The name of Leo Pargial has figured too long upon maps to be abandoned now, but the natives on both sides of the Bashahr-Tibet border call the peak Rio Pórgyúl. Rio is merely a different form of the word Ri, meaning mountain, as in Chumalhari.

4

ON THE ERRORS OF THE ADOPTED VALUES OF HEIGHT

The values of height given in tables I to VI of this paper must be accepted with caution; some are more reliable than others, but none are correct to a foot, and many investigations will have to be completed before altitudes can be determined with a greater degree of accuracy than at present.

All observations are liable to error; no telescope is perfect, no level is entirely trustworthy, no instrumental graduations are exact, and no observer is infallible.

Errors of observation.

In ordinary triangulation the objects to be observed are sharp and specially erected signals, but for the observations of a high peak, the summit, however ill-defined, cannot be furnished with a suitable mark.

If a flat-topped peak be observed from a near station, the surveyor runs the risk of mistaking some lower point for the summit, the latter being obscured from his view by an intervening shoulder.

Errors of measurement however can be greatly reduced and rendered practically negligible, if a peak be observed with a good theodolite on *several* occasions and from *different* stations; observations of Mount Everest, of K², of Kinchinjunga, and of others have been repeated so often and from so many different places that the local angles of elevation have been probably determined within one or two seconds of the truth and the errors in the mean values of height *due to faults of observation* are probably less than 10 feet. But in the cases of peaks Nos. 18 and 30 of table IV, and others, which have been observed from one station only and on but few occasions from that, errors due to faults of observation may attain to 100 feet. A single intersection of a peak from a single station deserves no weight whatever: it may give a result hundreds of feet in error.

Heights in the Himalaya that have been measured from one or two stations only may in places be thrown into error to the extent of 10 or 15 feet by the adoption of erroneous altitudes for the stations of observation.

The adoption of an erroneous height for the observing station.

In the case of the Karakoram and Ladak ranges the liability to error on this account is larger and is perhaps 30 feet: the peaks of the Hindu Kush have been observed from less known stations than those of the Karakoram and are possibly 70 feet in error in consequence.

The Kashgar range being still more remote from the triangulation of India, the heights of its peaks are less reliable than those of the Hindu Kush; and the peaks of Kungur and Muztagh Ata may be in error by 300 feet, or even more, on account of the accumulation of error in the assumed altitudes of the stations from which they have been observed.

An element of uncertainty is introduced into heights by the fact that the altitudes of peaks are always varying in nature with the increase and decrease of snow. The discrepancies that obtain

Variations of snow.

between the different determinations of height of the same peak may be partly due to the fact that some observations have been made after the snow has been accumulating, and others after it has been diminished by heat, evaporation, wind, and avalanches. All heights on land have to be measured from the surface of the sea, and as the latter rises and falls with the tides, a mean level of the sea has to be adopted; and so in the case of the great peaks, we shall have eventually to assume the mean level of the snow at their summits as the altitude to be determined.

A plumb-line is a string supported at its upper end and stretched by a weight

The deviation of gravity from the normal. attached to its lower end.* If there were no irregularities

of matter near the earth's surface a plumb-line would hang truly normal; but mountains exert a lateral pull, and tend to deflect it towards them. In the same way as plumb-lines are pulled out of the normal, so is the surface of water near mountains pulled out of its spheroidal form. The attraction of the great mass of the Himalaya and Tibet pulls all liquids towards itself, as the moon attracts the ocean, and the surface of water in repose assumes an irregular form at the foot of the Himalaya. If the ocean were to overflow northern India its surface would be deformed by Himalayan attraction. The liquid in levels is similarly affected and theodolites cannot consequently be adjusted: their plates when levelled are still tilted upwards towards the mountains, and angles of elevation as measured are too small by the amount the horizon is inclined to the tangential plane. At Darjeeling the surface of water in repose is inclined about 35" to this plane, at Kurseong about 51", at Siliguri about 23", at Dehra Dun and Mussooree about 37".

No attempt has yet been made to apply corrections to the values of heights on account of Himalayan attraction: the determinations of the deflections of the plumb-

* To render intelligible references to the deviation of gravity it is necessary to define the following words, *vertical*, *horizontal*, *normal*, *level*, *tangential*. If the earth had been at rest, it would under the influence of gravity have assumed the form of a sphere: its rotation round an axis has converted the sphere into a spheroid flattened at the poles. The present figure of the earth is not a perfect spheroid, however, as the surface is disfigured by mountains and valleys, which are rigid enough to withstand the influences of gravity and rotation. Everywhere in fact on land we meet with slopes and cliffs that are obviously inclined to the general surface of the earth. Water, however, whether it be in a basin, or lake or ocean, conforms closely to the spheroidal surface, and it is more exact to say that the figure of the sea is a spheroid, than that the figure of the earth is one. The surface of the sea, however, though more nearly spheroidal than that of the land, suffers from slight irregularities, and water in repose does not conform exactly to the spheroid. Continents and mountains attract water towards themselves, and their attraction disfigures the surfaces of oceans and ponds and levels. If the earth were a homogeneous and perfect spheroid, the direction of gravity would everywhere be perpendicular to its surface, but the earth is irregular, and gravity does not always coincide with the perpendicular to the general surface. Gravity acts in a direction perpendicular to the surface of water. We have then to consider what we mean by a *vertical* line—whether it is the perpendicular to the earth's mean surface or whether it is the direction of gravity. The word *vertical*, we think, should be employed to describe the direction of gravity; the line perpendicular to the mean surface should be called the *normal*. The actual surface of the sea and of water, however disfigured from a spheroid, is the *level* surface, and the word *level* should only be applied to this actual surface. The following definitions will explain the difference between the *horizontal* and *tangential* planes at any point of the earth's surface: the *horizontal* is the plane that is tangential to the local surface of water, however the latter may be deformed: the *tangential* plane is the plane that is tangential to the mean spheroidal surface.

line are at present not sufficiently perfect to justify the results being utilised to correct altitudes.*

We know that all angles of elevation to Himalayan peaks measured from the plains of India and from the outer hills are too small, and consequently all our values of Himalayan heights are too small. Errors of this nature range from 40 to 100 feet.

Of the deflection of gravity from the normal in Tibet or Kashgar or on the Karakoram or Hindu Kush we know as yet nothing.

If a peak be observed from different directions, the deflection of the plumb-line in the plane of the peak will probably be different at every observing station, and the several values of height may consequently appear discordant. Such discordances, however, are unavoidable; their presence implies that the direction of gravity has been varying, and it leads us to hope that the errors due to deflections of the plumb-line are tending to cancel in the mean.

The most serious source of uncertainty affecting values of heights is the refraction of the atmosphere. A ray of light from a peak to an observer's eye does not travel along a straight line, but assumes a curved path concave to the earth. The ray enters the observer's eye in a direction tangential to the curve at that point, and this is the direction in which the observer sees the peak. It makes the peak appear too high. Refraction is greatest in the morning and evening and least in the middle of the day: it is different in summer from what it is in winter. If we observe Dhaulagiri from the plains of Gorakhpur, it appears to fall 500 feet between sunrise and the afternoon, and to rise again 300 feet before sunset. Even in the afternoon, when it appears lowest, it will still be too high by perhaps 700 feet.

In 1853 Sir Andrew Waugh determined the curvature of the path of a ray of light between the outer Himalaya and the low plains of Bengal by means of simultaneous observations taken from both ends of the ray. He then assumed that the path of a ray to a snow peak would be similarly curved, and he reduced the apparent heights of the peaks accordingly. But we believe now that he reduced the heights by too much: his determination of a ray's curvature in the outer Himalaya was correct, but this curvature, we think, is not maintained at higher altitudes. As the rarefaction of the atmosphere increases, the ray assumes a less curved path, and Sir Andrew Waugh's method attributed to refraction a greater effect than it really has. To the Karakoram heights Colonel Montgomerie employed smaller corrections for refraction than Waugh used for the Himalaya.

* *Philosophical Transactions of the Royal Society of London*: Series A, Volume 205 (1905), pp. 239 to 318.

If we bring together in the following table the different errors to which carefully determined heights of peaks are liable it will help to focus our ideas:—

Summary of errors.

TABLE VIII.—Magnitudes of possible errors.

Source of error.	Great Himalaya range.	Karakoram range.	Kashgar range.
Variations of snow-level from the mean . . .	Unknown . . .	Unknown . . .	Unknown.
Errors of observation	10 feet . . .	20 feet . . .	100 feet.
Adoption of erroneous height for observing station	10 feet . . .	30 feet . . .	300 feet.
Deviation of gravity	60 feet, too small . . .	Unknown . . .	Unknown.
Atmospheric refraction	150 feet, too small . . .	10 to 30 feet	50 feet.

The following table shows how the different values of the height of Mount Everest Deduction of the height of have been deduced:—
Mount Everest.

TABLE IX.—Height of Mount Everest.

Station of observation.	Year of observation.	Height of station of observation.	Distance from Mount Everest.	Values of height, if no correction for refraction be applied.	Resulting height as determined by Waugh with co-efficients of refraction varying from 0.07 to 0.08 from stations in the plains.	Resulting height from computations in 1906 with co-efficient of refraction 0.05 from stations in the hills.	Resulting height with assumed co-efficient of refraction 0.045 from stations in the plains.
		Feet.	Miles.	Feet.	Feet.	Feet.	Feet.
Jirol	1849	220	118.661	30366	28991.6	..	29141
Mirzapur	1849	245	108.876	30165	29005.3	..	29135
Janjpati	1849	255	108.362	30141	29001.8	..	29117
Ladnia	1849	235	108.861	30171	28998.6	..	29144
Harpur	1849	219	111.523	30221	29028.1	..	29146
Minai	1850	228	113.761	30282	28990.4	..	29160
Suberkum	1881	11641	87.636	29576	..	29141	..
Do.	1883	11641	87.636	29572	..	29137	..
Tiger Hill	1880	8507	107.952	29860	..	29140	..
Sandakphu	1883	11929	89.666	29620	..	29142	..
Phallut	1902	11816	85.553	29589	..	29151	..
Senchal	1902	8599	108.703	29941	..	29134	..
Mean	..	..	..	..	29002	29141	29141
Range of variation in values*	..	..	..	794	Misleading.†	17	43

The 5th column gives the values of height obtained from observation, if no correction for refraction be applied. It will be noticed that all the values of height in this column derived from observations taken at low-lying stations exceed 30000 feet, whereas those derived from observations taken at high altitudes are less than 30000 feet.

The reason of this difference is that refraction tends to elevate a peak to a greater extent when the observation is made through the thick atmosphere of the plains than

* The range of variation is the difference between the largest and smallest values of height in the column above; it is the maximum discordance obtained, and as such it furnishes evidence as to the correctness of the refraction co-efficient adopted.

† The extent of the range of variation affords no useful information unless the same value for refraction has been employed throughout. By using selected values of refraction we can make all values of height identical and have no range of variation at all.

when the line of sight passes only through the rarefied air of hill stations. It will be noticed that when no correction for refraction is applied, the largest of the values in the 5th column differs from the smallest by 794 feet, but that the application of corrections reduces the discrepancies materially.

The height 29141 is still probably too small, as it has yet to be corrected for the effects of deviations of gravity. Though it is a more reliable result than 29002, the latter value is still to be retained in maps and publications of the Survey. We cannot claim to have solved the problems of refraction, nor to have eliminated all uncertainties: our knowledge of the deflections of gravity is still but superficial, and although we may endeavour continually to improve our heights, it would be a mistaken policy to introduce new values at every step of the investigation. Values of heights, as has been explained in a previous section, furnish means of identification and are not to be altered frequently or without good reason. We have discussed the height of Mount Everest to show the degree of uncertainty attaching to it, but we do not propose to substitute 29141 for the long adopted and well-known value 29002.*

It is probable that the accepted height of Kinchinjunga is, like that of Mount Everest, too small: the following table shows how the height of Kinchinjunga has been deduced:—

TABLE X.—Height of Kinchinjunga.

Station of observation.	Year of observation.	Height of station of observation.	Distance from Kinchinjunga.	Value of height, if no correction for refraction be applied.	Resulting height as determined by Waugh with co-efficients of refraction varying from 0·07 to 0·09 from stations in the plains.	Resulting height from computations in 1905 with co-efficient of refraction 0·08 from stations in the hills.	Resulting height with assumed co-efficient of refraction 0·0445 from stations in the plains.
		Feet.	Miles.	Feet.	Feet.	Feet.	Feet.
Dumdangi	1847	307	84·951	28858	28137·8	..	28224
Thakurganj	1847	264	88·491	28948	28138·3	..	28266
Bandarjula	1847	238	92·560	29080	28128·6	..	28312
Minai	1850	228	115·174	29494	28162·5	..	28346
Baisi	1850	234	115·631	29483	28152·1	..	28322
Harpur	1849	219	124·694	29651	28133·7	..	28297
Senchal	1847	8599	50·158	28401	28138·8	28231	..
Biroh Hill	1847	6874	44·907	28379	28152·3	28239	..
Tonglu	1847	10073	46·369	28370	28169·6	28220	..
Observatory Hill	1884	7162	45·720	28353	..	28212	..
Mean	..	..	..	..	28146	28226	28295
Range of variation in values †	..	..	..	1298	Misleading.‡	14	122

If we examine the results of the 5th column, which have not been corrected for refraction, we find that all the heights derived from observations at low-lying stations exceed 28800 feet, and all those derived from observations made at high altitudes are below 28410. The heavy atmosphere of the plains had greater refracting effects than the rarefied air of the hills and raised the peak to a greater extent.

* *Survey of India, Professional paper No. 9, 1905.*

† The range of variation is the difference between the largest and smallest values of height in the column above; it is the maximum discordance obtained and as such it furnishes evidence as to the correctness of the refraction co-efficient adopted.

‡ The extent of the range of variation affords no useful information unless the same value for refraction has been employed throughout. By using selected values of refraction we can make all values of height identical and have no range of variation at all.

If no correction for refraction be applied, the values of height vary from 28353 to 29651, a discrepancy of 1298 feet: the 7th and 8th columns show how this discrepancy can be reduced by corrections for refraction.

The following table shows how the height of Dhaulagiri was obtained: no observations have been taken to it from stations in the hills:—
Deduction of the height of Dhaulagiri.

TABLE XI.—Height of Dhaulagiri.

Station of observation.	Year of observation.	Height of station of observation.	Distance from Dhaulagiri.	Values of height, if no correction for refraction be applied.	Resulting height as determined by Waugh with co-efficients of refraction varying from 0.07 to 0.09.	Resulting height with assumed co-efficient of refraction 0.066.
		Feet.			Feet.	Feet.
Morairi	1848	334	105.975	27974	26791.0	27002
Banarai	1849	329	95.025	27928	26773.8	27128
Saonbarsa	1849	315	104.043	28093	26830.8	27151
Purena	1849	299	105.800	28011	26813.1	27044
Ghaos	1849	327	95.812	27852	26775.5	27052
Tulsipur	1848	376	104.461	27930	26824.8	26988
Anarkali	1848	434	137.340	28640	26756.6	27002
Mean	..	..	..	..	26795	27052
Range of variation in values *	..	..	..	788	Misleading.†	163

The height 26795 is too low: the reductions made on account of refraction were too great.

The observations in the North-West Himalaya of the great peaks of K², Nanga Parbat, etc., were taken not from low dusty hazy plains as those of the Nepalese peaks were, but from high stations, and the rays passed through a rarefied atmosphere.

The height of K² was deduced by Colonel Montgomerie as follows:—
Deduction of the height of K².

TABLE XII.—Height of K².

Station of observation.	Year of observation.	Height of station of observation.	Distance from K ² .	Values of height, if no correction for refraction be applied.	Resulting height as determined by Montgomerie with co-efficients of refraction varying from 0.04 to 0.05.
		Feet.			Feet.
Shangruti	1859	17531	78.9	28640	28246.6
Biaohuthusa	1859	16746	99.0	28846	28218.7
Marabala	1858	16906	58.6	28472	28240.0
Kastor	1858	15983	66.0	28560	28261.4
Thurigo	1858	17246	61.8	28515	28254.1
Haramukh	1856	16001	130.5	29300	28293.9
Kanuri-Nar	1857	15437	114.3	28920	28218.4
Barwai	1857	16304	88.0	28666	28258.5
Thalanka	1857	16830	74.7	28613	28322.7
Mean	..	..	..	..	28253
Range of variation in values *	..	..	..	823	104

* The range of variation is the difference between the largest and smallest values of height in the column above; it is the maximum discordance obtained and as such it furnishes evidence as to the correctness of the refraction co-efficient adopted.

† The extent of the range of variation affords no useful information unless the same value for refraction has been employed throughout. By using selected values of refraction we can make all values of height identical and have no range of variation at all.

The following table shows the height of Nanga Parbat as deduced from the observations using different refraction co-efficients :—

TABLE XIII.—Height of Nanga Parbat.

Station of observation.	Year of observation.	Height of station of observation.	Distance from Nanga Parbat.	HEIGHT WITH REFRACTION CO-EFFICIENTS OF										
				0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
		Feet.	Miles.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Ahartatopa . . .	1855	13029	133.744	27885	27646	27407	27168	26929	26689	26449	26210	25970	25734	25494
Pahargarh . . .	1855	11856	118.751	27690	27492	27304	27116	26928	26739	26551	26362	26174	25988	25800
Gogipetri . . .	1855	7752	95.055	27332	27211	27090	26969	26848	26726	26604	26485	26363	26243	26124
Haramukh . . .	1856	16001	59.275	26882	26835	26788	26741	26694	26647	26599	26552	26505	26460	26413
Kajmag . . .	1856	12111	78.559	27028	26956	26884	26812	26740	26669	26595	26524	26452	26380	26307
Poahkar . . .	1856	8323	83.491	27219	27125	27031	26937	26843	26749	26654	26562	26468	26376	26282
Ismael-di-dori . . .	1856	12630	63.805	26947	26892	26837	26782	26727	26671	26617	26563	26508	26454	26400
Safapur . . .	1856	10296	66.339	26917	26858	26799	26740	26681	26624	26564	26506	26447	26387	26329
Hant . . .	1856	13479	43.167	26771	26746	26721	26696	26671	26646	26621	26596	26572	26546	26522
Manganwar . . .	1856	8715	56.510	26854	26811	26768	26725	26682	26638	26596	26553	26510	26467	26425
Marinag . . .	1856	11814	46.342	26780	26751	26722	26693	26664	26636	26606	26579	26549	26520	26492
Mean . . .	..	..	..	27118	27029	26941	26853	26764	26676	26587	26499	26411	26323	26235
Range of variation in values*	..	..	..	1114	900	686	475	265	125	205	386	602	812	1028

It will be noticed that when a co-efficient of 0.10 is used, the height of Nanga Parbat as determined from different places varies between 25494 and 26522, a range of 1028 feet.

This great variation shows that the co-efficient of 0.10 is inapplicable: with a co-efficient of 0.09 the height varies from 25734 to 26546, a range of 812 feet. The range of variation decreases, until with a co-efficient of 0.05 all the values of height fall between 26624 and 26749, a range of 125 feet. If we decrease the co-efficient still further to 0.04, the variations again begin to increase, and the range extends to 265 feet, from 26664 to 26929: if the co-efficient be decreased to 0.00 the range of variation becomes 1114 feet.

The actual height adopted by Montgomerie for Nanga Parbat was 26620, and we are unable to improve upon his value: it is produced if a general co-efficient of 0.057 be accepted for refraction.

Is the great Himalaya range still rising? This is a question often asked but which no one has been able to answer. The observations of peaks made between 1850 and 1860 were not sufficiently prolonged at any one station to enable us to rely with certainty on the values of height then obtained. When the absolute height of a peak is being measured, stations of observation have to be multiplied in order to cancel effects of refraction and gravity, but when a slow variation in height is being determined, it is better to carry out long series of observations from one station only. In the latter case differences are being sought, not absolute heights, and all that is necessary is to repeat observations

* The range of variation is the difference between the largest and smallest values of height in the column above; it is the maximum discordance obtained and as such it furnishes evidence as to the correctness of the refraction co-efficient adopted.

from the same station, on the same days of the year, and under the same conditions. In 1905 a series of observations was commenced from the trigonometrical station of Nojli, and it is proposed to observe the heights of several peaks for some years and at different seasons in each year. If a reliable series of results be once obtained, a similar set of observations can be repeated at a subsequent date and any actual change of height that has occurred in the interim may be discovered.

The Siwalik range was elevated at a more recent date than the Himalaya, and is the most likely of all the ranges to be rising still : a bench-mark has been placed on the crest-line south of Dehra Dun, and its height has been determined by spirit levelling : if the bench-mark is preserved, future changes in altitude should be discoverable.

Slow changes in the level of land, unaccompanied by sudden movements, have been observed to occur along many coasts. At great distances from the sea such changes would take place without being noticed : without the aid of the sea as a datum we do not observe slow gradual movements, and a continuous rise of a foot a year might go on for centuries without attracting the attention of man. If an earthquake occurs and a tract of land suddenly subsides along a line of fracture in the crust, the result is apparent and measurable, but if the elevation of a large area takes place in all directions gradually and without fracture of the crust or any marked upheaval it may be considerable and yet escape observation. In the Dharmasala earthquake of 1905 an immense region may have been elevated or depressed through many feet, but if the change were nowhere sudden we should not without refined trigonometrical observations become aware of its occurrence.



Photogravure

Survey of India Office Calcutta, December 1906

NOJLI TOWER.

A STATION OF THE GREAT TRIGONOMETRICAL SURVEY, BUILT IN THE PLAINS OF UPPER INDIA NEAR ROORKEE,
AND FROM WHICH THE HIMALAYAN PEAKS OF BADRINATH, KEDARNATH, JAOJLI AND BANDARPUNCH HAVE BEEN OBSERVED.
FROM A PHOTO BY C. D. SIMONS.

5

ON THE FREQUENCY WITH WHICH PEAKS OF CERTAIN HEIGHTS TEND TO OCCUR.

Lest this review should degenerate into tables of numerical data we have refrained from continuing the lists of peaks below 24000 feet, but in deducing the continuity of ranges amid a vast mountainous area it is necessary to take into account the lower peaks.

The following table shows the total number of peaks exceeding 20000 feet that have been discovered. The chart forming the frontispiece illustrates the ranges to which the several peaks of the table have been allotted :—

TABLE XIV.—The numbers of peaks of different altitudes which have been discovered in Asia.

Region.	Range.	Between 20000 and 21000 feet.	Between 21000 and 22000 feet.	Between 22000 and 23000 feet.	Between 23000 and 24000 feet.	Peaks of 5th magni- tude 24000 to 25000 feet.	Peaks of 4th magni- tude 25000 to 26000 feet.	Peaks of 3rd magni- tude 26000 to 27000 feet.	Peaks of 2nd magni- tude 27000 to 28000 feet.	PEAKS OF FIRST MAGNITUDE.	
										28000 to 29000 feet.	Above 29000 feet.
Trans- Tibetan.	Tian Shan	..	..	..	1	..	..	..	..	..	..
	Trans Alai	..	1	1	..	..	..	..	..	..	..
	Kashgar	1	..	2	..	1	2	..	..	..	..
	Sarikol	1	..	..	..	..	..	..	..	..	..
North- West Tibet.	Kuen Lun	57	28	10	3	1	..	..	..	..	..
	Aghil	24	2	1	..	..	..	..	..	..	..
	Karakoram	92	71	28	10	7	10	4	..	1	..
	Hindu Kush	49	29	13	9	3	1	..	..	..	..
Southern Tibet.	Kailas, West	9	8	5	..	2	1	..	..	..	..
	Kailas, East	11	12	..	2	..	..	..	..	..	..
	Ladak, West	11	5	1	..	..	..	..	..	..	..
	Ladak, East	11	12	5	..	..	1	..	..	..	..
	Ninchinthagla . . .	5	3	1	1	..	..	..	..	..	..
	Zaskar	20	11	6	2	..	1	..	..	..	..
Himalaya .	Great Himalaya range—										
	(In Assam)	9	3	6	6	3	..	..	..	..	..
	(In Nepal)	15	35	33	17	9	13	6	2	1	1
	(In Kumaun)	27	24	32	9	1	2	..	..	..	..
	(In Punjab)	7	6	2	2	..	1	1	..	..	..
Himalaya .	Lesser Himalaya range (between Kulu and Lahaul)	5	..	..	..	..	..	..	..	..	..
	Total	354	250	146	62	27	32	11	2	2	1

Russian surveyors probably know of more peaks exceeding 20000 feet than we have been able to allot to the Tian Shan and Trans Alai ranges : but they have only discovered one peak above 23000 feet,—Tengri Khan (*vide* table vi). The highest peak of the Trans Alai range is Kaufmann (table vi).

Twenty-seven peaks exceeding 20000 feet have been allotted in the table to the Aghil range : these peaks when plotted appear to stand between the Karakoram and Kuen Lun ranges, but they are insufficient in number to enable the intervening ranges to be traced : it is possible that some of these peaks belong properly to the Karakoram range and some to the Kuen Lun : no certain distribution can be made at present, and the trend of the Aghil range as shown on the frontispiece chart must be regarded as problematical.

The single peak of the Ladak range that exceeds 25000 feet in height is Gurla Mandhata : the great peak of the Zaskar range is Kamet : the highest peak of the Kailas range is Rakaposhi. The Kailas and Ladak ranges have for convenience been divided into east and west sections at lake Manasarowar.

The totals in table XIV show us that more peaks of the fourth magnitude have been discovered than of the fifth. This phenomenon is so striking that it is necessary to consider whether it can be due in any way to snow-fall,—whether there can exist some critical altitude at which a maximum amount of snow tends to accumulate.

The term “ snow-line ” is the line through a mountain region along which the quantity of snow that falls annually is equal to the quantity that is melted annually ; below this line more snow can be melted in a year than actually falls ; above the snow-line more snow falls than can be melted. In the Kumaun Himalaya the snow-line was determined by General Richard Strachey to be 15500 feet on the south side of the great range and 18500 feet on the north side.*

As we ascend above the snow-line, we find the depth of perpetual snow tending to increase, but we do not know at what altitude in any given region the accumulation becomes a maximum. As the altitude increases, less snow is melted in the year, but the amounts removed by wind and evaporation may for what we know to the contrary be greater : the snow-fall moreover itself decreases with height, and at a certain altitude the decrease in fall begins to produce a diminution in the amount annually accumulated.

The problem is complicated too by considerations other than meteorological. A flat-topped summit will accumulate greater masses of snow than a precipitous and pointed peak. Mountains such as K², Nanga Parbat, or Rakaposhi are too sharp to allow the snow to lie in quantity ; as soon as snow falls upon them it descends in the form of avalanches to lower levels and hardens into glacier-ice. But the great Tirich Mir group of peaks have rounded tops, which have possibly been formed by constant accumulations of snow.

The question is therefore not simply one of the balance of snow-fall and melting, for the shape of a peak is a most important factor. The peaks on which snow has been accumulating for centuries are those possessing flat tops, and as flat tops are not more likely to occur at one altitude than at another, it is not possible to attribute

* *Vide* Section 19, Part II of this paper.

the great number of peaks of the fourth magnitude to excessive accumulations of snow at 25000 feet.

In the Himalayan system of ranges the great peaks may be divided into twelve groups: in two the principal peaks exceed 28000 feet, in five the principals lie between 26000 and 27000 feet, in three between 25000 and 26000, and in only two are the principals between 24000 and 25000.*

Peaks of 24000 feet are comparatively rare.

In the Karakoram system the same paucity of 24000 feet peaks is observed: one group surrounds a principal exceeding 28000 feet; seven groups surround principals of 25000 feet, and in two groups only are the principals of 24000 feet.

In the Himalayan system there are many groups of peaks the principals of which rise to 23000 feet: amongst others table VI shows Api (23399 feet), Badrinath (23190 feet), Chumalhari (23930 feet), Dayabhang (23750 feet), Gaurisankar (23440 feet), Ser or Nana (23410 feet).

So far then as observations have gone, peaks of 24000 feet have been found to be relatively rare, and principals of groups of that height very rare. At the same time the incompleteness of the trigonometrical survey has to be borne in mind; the peaks of Nepal were observed from very distant stations situated on the low-lying plains of India, and some are known to have been hidden from observers by clouds. A trigonometrical surveyor has no fixed observatory in which he can wait with patience for clear days: he has to observe from many stations in the course of a year, and has always to be moving forward. In observing important peaks he may consider it justifiable to delay for days to ensure that no great altitude has been missed, but some of the minor peaks may be lost, if clouds are persistent.

For weeks together the snow-peaks will be visible for a short time after sunrise, and then become obscured for the rest of the day by clouds or dust-haze rising off the plains: the surveyor utilises the few minutes at his disposal in observing carefully the principal peaks in view, but he has not the time to make an exhaustive study of the range. So long as the Nepal peaks have to be observed from distances of 100 miles the trigonometrical survey will remain incomplete.†

In view of the known incompleteness of the survey, as a whole, a discussion of the numbers of peaks of the fourth and fifth magnitudes may be considered superfluous. But though the data are insufficient to justify conclusions being drawn, observed peculiarities are deserving of notice. The surface features of the solid earth do conform generally to the laws of probability: half the whole surface of the lithosphere is situated within 700 feet of sea-level, and the highest heights and the deepest deeps occur very rarely. It was reasonable to expect that we should discover more peaks of 20000 feet than of 21000 feet and more of 23000 feet than of 24000, and this we have done: but

* The actual number of Himalayan groups is ten; Kamet and Gurla Mandhata raise the total to twelve.

† The Kumaon and Punjab Himalaya have however been very closely examined and the absence of peaks of 24000 feet is more marked than in Nepal.

Colonel Tanner, who observed the peaks of Nepal from many different places, with the object of supplementing the previous observations of the Great Trigonometrical Survey, wrote "Very few of the great peaks escaped the observers of the Trigonometrical Survey."

there is one striking exception to the rule,—*the peaks of the fourth magnitude exceed in number those of the fifth.*

From present data it is difficult to calculate by the law of probability how many peaks of any particular altitude may be expected to exist in a given region; we have as yet no satisfactory basis. We cannot, for instance, take the peaks of 20000 and 21000 feet as our data and deduce from them the probable numbers of other heights, because we know that many peaks of 20000 and 21000 feet have escaped our surveyors and that our observed numbers are in defect of reality.

We can calculate the probable numbers of peaks upon the hypothesis that all existing peaks above 26000 feet have been discovered, but this hypothesis is not satisfactory as it gives undue weight to the few highest peaks.

Finally, we can take the peaks of 25000 and 26000 feet, and assuming that no others of such heights exist undiscovered, we can deduce the probable number of peaks of all heights. The objection to this hypothesis is that there are reasons for believing that the number of peaks of 25000 feet is larger than the law of probability would give.

In the following table is shown the number of peaks of each altitude that the law of probability would lead us to expect to find:—

TABLE XV.—Comparisons between probable and actual numbers.

Height in feet.	Probable number of peaks on the assumption that there exist eleven between 26000 and 27000 and one peak above 29000 feet.	Actual number of peaks discovered.	Discrepancy between probables and actuals.	Probable number of peaks on the assumption that there exist eleven peaks between 26000 and 27000 and thirty-two between 25000 and 26000 feet.	Actual number of peaks discovered.	Discrepancy between probables and actuals.
Above 29000	1	1	0	1	1	0 ..
Between 28000 and 29000 ..	2	2	0	1	2	+1 ..
„ 27000 and 28000 ..	5	2	—3	4	2	—2 ..
„ 26000 and 27000 ..	11	11	0	11	11	0 ..
„ 25000 and 26000 ..	23	32	+9	32	32	0 ..
„ 24000 and 25000 ..	47	27	—20	84	27	—57 ..
„ 23000 and 24000 ..	93	62	—31	218	62	—156 ..
„ 22000 and 23000 ..	179	146	—33	544	146	—398 ..
„ 21000 and 22000 ..	335	250	—85	1302	250	—1052 ..
„ 20000 and 21000 ..	607	354	—253	2996	354	—2642 ..

In the first half of this table the probable numbers are calculated on the assumption that eleven peaks between 26000 and 27000 feet exist and one peak of 29000 feet. On this assumption the actual number of peaks below 25000 feet is shown throughout to be less than the probable number,—a deficiency that can only be regarded

as reasonable seeing that many peaks of these heights are known to be still unobserved. The curious feature of this portion of the table is that the actual number of peaks between 25000 and 26000 feet exceeds the probable number by 9. The meaning of this excess is that *the number of existing peaks between 25000 and 26000 feet is greater than would be expected from the number known to exist above 26000 feet.*

In the second half of the table the probable numbers have been calculated on the assumption that eleven peaks exist between 26000 and 27000 feet and thirty-two between 25000 and 26000 feet. The result of including these thirty-two peaks in the data is to increase greatly the numbers of inferior peaks: the increase becomes enormous if the table is extended down to 16000 feet,* and the numbers of peaks then shown as probably existing are clearly in excess of the actuals. The meaning of this excess is that *the number of existing peaks between 25000 and 26000 feet is greater than would be expected from the number believed to exist below 25000 feet.*

Whilst then we recognise the insufficiency of our data, we think that the results of table xv are not without interest: we find from that table that the number of peaks between 25000 and 26000 feet is unduly great, whether they be compared with those above 26000 or with those below 25000 feet.

The height of the rock summit of a peak is the resultant effect of two forces,—(i) the force of compression which elevated the range, (ii) the erosive force which is lowering the range. The rock summit is covered by an unknown amount of snow. If we reject the snow-covering as insignificant in effect, we shall have to assume that the combined actions of the compressing and eroding forces have tended to produce in Asia an exceptional number of peaks attaining 25000 feet.

* Probable numbers of peaks :—

Height in feet.	Basis of calculation : one peak above 28000, eleven peaks between 26000 and 27000 feet.	Basis of calculation : eleven peaks between 26000 and 27000, thirty-two peaks between 25000 and 26000 feet.
Between 19000 and 20000 .	. . 1070 . .	. . 6616 . .
„ 18000 and 19000 .	. . 1833 . .	. . 14030 . .
„ 17000 and 18000 .	. . 3048 . .	. . 28566 . .
„ 16000 and 17000 .	. . 4923 . .	. . 55848 . .

6

ON THE GEOGRAPHICAL DISTRIBUTION OF THE GREAT PEAKS.

One of the difficulties encountered in the classification of mountain-peaks is that absolute altitude is not a true indication of regional importance.

The presence of a peak of 20000 feet that surpasses in height all other surrounding summits furnishes more instructive lessons than one like Jano (25294 feet), which is a mere projection from a buttress of Kinchinjunga.

Peaks may in fact be divided into four classes according to their relative local importance :

- (i) There is the *principal* of a group like Everest (29002 feet) or Tirich Mir (25426 feet).
- (ii) There is the *twin* of the principal like Kinchinjunga II (27803 feet) or Mer (23250 feet)—situated in close proximity to the principal and rivalling it in altitude.
- (iii) There is the *companion* like Makalu or Gasherbrum, which situated in the vicinity of the principal is 1000 or perhaps 2000 feet lower.
- (iv) There is the *satellite* like Jano or Kabru, 3000 or 4000 feet lower than the principal.

In the following table the great peaks of the Himalaya are divided into regional groups : those that are twins are marked by an asterisk. The numbers of the peaks are taken from tables I to V of this paper.

TABLE XVI.—An analysis of the great peaks of the Himalayan system.

Groups as numbered from east to west	Position of the group.	Number of great peaks in the group.	The great peaks.	Height.	Position of each peak in the group.	Notes.
Group I (Kulu Kangri).	The easternmost group.	3	No. 51* . . . " 54* . . . " 59 . . .	Feet. 24740 24660 24496	3000 yards N. N. W. of No. 51. 15 miles N. E. of No. 51.	
Group II (Kinohinjunga).	140 miles west of group I.	7	No. 3* Kinohinjunga " 4* . . . " 20 Kambechen . " 37 Jano . . . " 64 . . . " 72 . . . " 75 Kabru . . .	28146 27803 25782 25294 24344 24089 24002	1600 yards S. S. E. of No. 3. 1 mile N. of No. 3. 6 miles W. of No. 3. 11 miles N. of No. 3. 6 miles N. N. E. of No. 3. 6 miles S. of No. 3.	
Group III (Everest)	63 miles west of group II.	9	No. 1 Mount Everest " 5 Makalu . . . " 6 . . . " 17* . . . " 18* . . . " 30 . . . " 33 . . . " 40 . . . " 74 Chamlang .	29002 27790 26867 25990 25909 25433 25413 25202 24012	A single pyramid. 12 miles S. E. of No. 1. 16 miles W. N. W. of No. 1. 13 miles W. N. W. of No. 1 and 5 miles from No. 6. 14 miles W. N. W. of No. 1 and 2 miles from No. 6. 20 miles W. N. W. of No. 1 and 3 miles from No. 6. 12 miles E. S. E. of No. 1 and 2 miles from No. 5. 16 miles W. N. W. of No. 1 and 3 miles from No. 6. 15 miles S. S. E. of No. 1.	If we analyse group III, we see that Everest stands alone on the Tibetan side of the crest, that no other great peak is within 10 miles of it, and that 5 peaks are crowded together 15 miles to the W. N. W. It is known that the list of the peaks of the Everest group is incomplete: during the observations by the Great Trigonometrical Survey and subsequently during those by Colonel Tanner, the group was persistently obscured by clouds, and some high peaks to the S. W. of Everest were lost. They were seen several times and observed more than once, but their shapes were not sufficiently distinguished through the hazy atmosphere and amid the distant clouds to admit of their identification from two points.

TABLE XVI—continued.

Groups as numbered from east to west.	Position of the group.	Number of great peaks in the group.	The great peaks.	Height.	Position of each peak in the group.	Notes.
				Feet.		
Group IV (Gosainthan).	60 miles west of group III.	2	No. 13 Gosainthan " 43 . . .	26291 25134	2 miles E. of No. 13.	
Group V	39 miles west of group IV.	1	No. 67 . . .	24299		
Group VI	34 miles west of group V.	3	No. 8 . . . " 19 . . . " 21 . . .	26358 25601 25705	10 miles S. E. of No. 8. 3 miles S. of No. 8.	
Group VII	26 miles west of group VI.	4	No. 10 . . . " 15 . . . " 50 . . . " 53 . . .	26492 26041 24760 24688	18 miles E. of No. 10. 10 miles E. of No. 10. 10 miles E. of No. 10.	
Group VIII (Dhaulagiri).	21 miles west of group VII.	6	No. 7 Dhaulagiri " 31* . . . " 38* . . . " 46 . . . " 49 . . . " 70 . . .	26795 26429 25271 25084 24885 24150	7 miles W. N. W. of No. 7. 8 miles W. N. W. of No. 7. 11 miles W. N. W. of No. 7. 9 miles W. N. W. of No. 7. 17 miles W. N. W. of No. 7.	No. 49 is on the same ridge and in the same alignment as Nos. 31 and 38. No. 39 stands in the centre of the ridge, with No. 31 at a distance of 0.90 mile N. E. and with No. 40 at a distance of 2.51 miles S. W. This ridge is a rare example of a linear summit surmounted by 3 great peaks of almost the same altitude.
Group IX (Kumaun).	250 miles west of group VIII.	3	No. 23* Nanda Devi " 26* . . . " 61 . . .	25645 25563 24391	Within 100 yards of No. 23. 1½ miles E. S. E. of No. 23.	No. 61 stands in the prolongation of the ridge connecting the Nanda Devi twins. This is an example of a three-peaked linear summit.
Distant outliers of the Kumaun group.		2	No. 29 Kamet . . . " 36 Guria Mandhata	25447 25355	40 miles N. N. W. of No. 23. 80 miles E. of No. 23.	These peaks are in Tibet and are not situated on the Great Himalaya range itself; their presence indicates that the Tibetan ranges beyond the Himalaya have been exceptionally elevated north of Kumaun.
Group X (Kashmir).	458 miles west of group IX.	2	No. 9 Nanga Parbat. " 25 . . .	26620 25572	1 mile N. N. W. of No. 9.	Throughout the great distance of 458 miles separating groups IX and X no known peak exists exceeding 4000 feet in height.

A SINGLE PEAKED SUMMIT



Photogravure

NANGA PARBAT
AS SEEN FROM A DISTANCE OF 80 MILES

From a Post Box for General George Graham, H.I.

A DOUBLE PEAKED SUMMIT



Survey of India Office, Calcutta, December 1906

RANDAR PUNCH
AS SEEN FROM A DISTANCE OF 40 MILES

From a Post Box for General George Graham, H.I.

Out of the 75 peaks of Asia that are known to exceed 24000 feet in height, 42 have been distributed amongst the ten groups above and may be regarded as belonging to the Himalayan system.

TABLE XVII.—Summary of Himalayan peaks.

No. of group.	Name of group.	No. of great peaks exceeding 24000 feet.
I	Kulha Kangri	3
II	Kinchinjunga	7
III	Everest	9
IV	Gosainthan	2
V		1
VI		3
VII		4
VIII	Dhaulagiri	6
IX	Kumaun	3
X	Kashmir	2
Total number of great peaks on Himalayan range		40
Total number of Trans-Himalayan great peaks north of Kumaun group.		2
Total		42

We described on page 10 how few peaks were really peaked in the true sense of the word; and of true peaks there is hardly one that can be accurately described as solitary. Nanga Parbat (26620 feet) is the most famous example of a solitary cone, but even Nanga Parbat has a companion (25572 feet) standing at a distance of a mile and a satellite (23170 feet) within 3 miles.

Gurla Mandhata is often described as a solitary peak, but it has two satellites: one of these, 22846 feet in height, stands 2 miles N. of its principal; the other is 22673 feet and 3 miles E.N.E.

Kamet appears on the charts to be standing alone on the border of Tibet, but the peak of Mana (23862 feet) is within 3 miles of it.

The accompanying plate contains two drawings by Colonel George Strahan, R.E. That of Nanga Parbat furnishes a fine example of a solitary peak. The other shows the twin peaks of Bandarpunch with their connecting ridge resembling a suspended chain; these twin peaks are 3000 yards apart and 20720 and 20017 feet in height respectively.

Of the great peaks of Asia the thirty-three that stand north of the Indus may be considered as belonging to the Karakoram system.† In the following table they are divided into regional groups. Throughout this system twin peaks are a common form of summit; they are marked with an asterisk in the table. The distinguishing numbers of the several peaks are taken from tables I to V of this paper.

TABLE XVIII.—An analysis of the great peaks of the Karakoram system.

Groups as numbered from east to west	Position of the group.	Number of great peaks in the group.	The great peaks.	Height.	Position of each peak in the group.	Notes.
Group XI (Shyok Nubra).	Between Shyok and Nubra rivers.	3	No. 41 . . . " 55* . . . " 57* . . .	Feet. 25170 24850 24590	5 miles S. E. of No. 41. 3 miles S. E. of No. 41.	
Group XII .	20 miles west of group XI.	1	No. 52 . . .	24890		
Group XIII .	35 miles from No. 52.	3	No. 34* K ¹ . . . " 38* K ¹¹ . . . " 63 K ¹² . . .	25400 25280 24370	Within ‡ a mile of one another. 13 miles S. E. of No. 34.	
Group XIV (Karakoram).	22 miles west of group XIII.	8	No. 2 K ³ . . . " 11* K ³ Gasherbrum . . . " 12* . . . " 14* . . . " 16* . . . " 23* Masherbrum . . . " 24* . . . " 45 . . .	28250 26470 26360 26090 26000 25690 25610 25110	The Gasherbrum quadruplet comprising 4 great peaks standing on a crescentic line 5 miles long is situated some 11 or 12 miles to the S. E. of K³. 18 miles S. W. of K³. 18 miles S. of K³. 11 miles S. S. W. of Gasherbrum. 16 miles E. S. E. of Masherbrum.	Gasherbrum furnishes the only instance amongst the great peaks of so many as 4 of equal altitude being situated on one ridge. Two of the peaks Nos. 12 and 14 are within 1200 yards of one another, a third No. 16 lies in the alignment 2 miles to the east, and a fourth No. 11 lies two miles to the west. Peaks Nos. 22, 24 and 45 are situated in the prolongation of the alignment in which the groups XI, XII and XIII are ranged, but K³ and the four Gasherbrum peaks are situated on a parallel alignment some 15 or 16 miles to the N.E. It is possible that the summit of the range is corrugated, and that there are two distinct folds, the Gasherbrum peaks standing on the one, the Masherbrum on the other. The Karakoram group is very complicated: its seven peaks lie on the perimeter of an oblong area, which extends for 15 miles, in the direction of the range and for 18 miles astride the range. K³ is at the northern corner of the oblong, Masherbrum is at the western corner and Gasherbrum at the eastern corner. No great peak has been discovered inside this area.

† For name "Karakoram" see Section 16 of Part II.

TABLE XVIII—continued.

Groups as numbered from east to west.	Position of the group.	Number of great peaks in the group.	The great peaks.	Height.	Position of each peak in the group.	Notes.
Group XV (Kunjut).	60 miles west of group XIV.	3	No. 28 . . . " 58 . . . " 71 . . .	Feet. 25480 24580 24080	10 miles W. of No. 28. 24 miles W. N. W. of No. 28.	
Group XVI (Hunza Kunji).	22 miles west of group XV.	4	No. 35 . . . " 44 . . . " 47 . . . " 73 Hunza-Kunji.	25370 25118 25050 24044	2 miles N. N. W. of No. 35. 11 miles E. S. E. of No. 35. 13 miles E. S. E. of No. 35.	There are many peaks of 22000 and 23000 feet in this group. A curvilinear alignment of peaks exceeding 20000 feet can be traced westwards from the Hunza-Kunji group for 80 miles: it is then broken by the Kunar river, but the continuation of the alignment can be traced for a further 60 miles as far as the great group of Tirich Mir.
Group XVII (Tirich Mir).	140 miles west of group XVI.	4	No. 32 Tirich Mir . . . " 56 * . . . " 65 * . . . " 69 Sad Ishtagh . . .	25426 24611 24343 24171	10 miles N. of No. 32. 9 miles N. N. E. of No. 32. 26 miles N. E. of No. 32.	To the westward of Tirich Mir no great peaks have been discovered.
Group XVIII	Between the Indus river and the Karakoram range.	3	No. 27 Rakaposhi . . . " 60 . . . " 68 Haramosh . . .	25550 24470 24270	25 miles E. S. E. of No. 27. 32 miles S. E. of No. 27.	This group stands north of the Indus, but south of the Karakoram range: its peaks are separated by so great distances that they can hardly be described as composing one group: they are however all situated on the same range, and are the only great peaks of that range: they can therefore be conveniently classed together. On the frontispiece chart this range has been designated the Kailas range.
Group XIX (Kashgar).	East of the Pamir plateau.	3	No. 42 Kungur . . . " 48 . . . " 62 Muztagh Ata . . .	25146 25048 24388	7 miles E. S. E. of No. 42. 28 miles S. S. W. of No. 42.	These three peaks are on the Kashgar range (see frontispiece chart); they are isolated, being 140 miles from the nearest group.
Group XX (Kuen Lun).	North-West Tibet	1	No. 66 Kuen Lun . . .	24306		The only peak of the Kuen Lun range that has been found to exceed 24000 feet in height.

The ten groups of the Karakoram system may now be summarised :—

TABLE XIX.—Summary of Karakoram peaks.

No. of group.	Name of group.	No. of great peaks exceeding 24000 feet.
XI	Shyok Nubra	3
XII		1
XIII		3
XIV	Karakoram	8
XV	Kunjut	3
XVI	Hunza-Kunji	4
XVII	Tirich Mir	4
Total number of great peaks on the Karakoram range . .		26
XVIII	Great peaks between the Indus river and the Karakoram range	3
XIX & XX	Great peaks north of the Karakoram range	4
Total number of great peaks in the Karakoram system . .		33

Colonel Tanner has pointed out that the imposing appearance of a peak depends not on absolute height but on the amount of its slope exposed to view, and he gave the following table of peaks which he had observed, to show the superiority in appearance of Nanga Parbat.

TABLE XX.

Name of peak.	As seen from	Distance.	Height of slope exposed to view.
		Miles.	Feet.
Mount Everest . .	Purnea, Bengal	118	8000
Mount Everest . .	Sandakphu on Singalila ridge	90	12000
Makalu	Purnea, Bengal	120	8000
Makalu	Sandakphu	79	9000
Nanga Parbat . .	From the right bank of the Indus	40	23000
Tirich Mir . . .	On the road from Gilgit to Chitral	40	18000
Rakaposhi . . .	Chaprot	40	18000
Kinchinjunga. .	Darjeeling	46	16000

7

THE GEOLOGY OF THE GREAT PEAKS.

In dealing with the great peaks the geologist is at no small disadvantage as compared with the surveyor, whose instruments enable him to work from a distance and to fix with accuracy the position and height of the object of his observation. The geologist, on the other hand, must toil arduously up the mountain sides, examining at close quarters such outcrops of rocks as he can find clear of snow, and, where further progress is barred, must depend for his information on fallen fragments, splintered from the cliffs above and brought down by avalanches and glaciers to form moraines and talus heaps. Thus the composition of the highest peaks is rarely known in any detail, but the general character of the rocks can be ascertained, with a fair approximation to certainty, from observation of the material on their flanks, and from a distant view of the weathering characters and apparent structure of the peaks themselves: it has thus been found that almost all those of 25000 feet or more in height are composed of granite, gneiss, and associated crystalline rocks.

Of the granite there are at least two varieties, a foliated rock composed essentially of quartz, felspar, and biotite (black mica), and a younger non-foliated form containing, in addition to quartz and felspar, white mica (muscovite), black tourmaline, beryl, and various accessory minerals. The former variety was long regarded as a sedimentary rock which had been converted by heat and pressure into gneiss, but its truly intrusive nature was recognised by the late Lieutenant-General C. A. McMahon,* who proved conclusively that the great central gneissose rock of the Himalaya was in reality a granite crushed and foliated by pressure. This rock is frequently pierced by veins of the second or non-foliated variety, and where these run parallel to the foliation planes, they lend to the series a deceptive appearance of bedding and cause it, when seen from a distance, to be mistaken for a mass of stratified deposits. This is a common characteristic of the higher peaks and may be noticed in many of the granitic masses of the great Himalayan range.

Although our experience leads us to assume that all the highest peaks are composed largely of granite, many more observations must be made before this can be positively asserted to be the case. Thus the most important mass of all, the Everest group, is still a blank on our geological maps, and so also is Kulha Kangri in Bhutan. Between these two, however, we know that all the most important peaks are formed of granite. Thus Chumalhari (23930 feet) is composed of foliated (gneissose) granite penetrated by veins of the non-foliated variety, and flanked by the altered representatives of slates and limestones metamorphosed by the granite which has been forced up through them from below. Further to the west, the Kinchinjunga group is also formed of granite,† flanked by metamorphic rocks certainly in part derived from pre-existing

* *Records, Geological Survey of India*, Vol. XV (1882), p. 44, Vol. XVI (1883), p. 129, and *Geological Magazine*, Dec. III, Volume 4 (1887), p. 215.

† E. J. Garwood in D. W. Freshfield's *Round Kangchenjunga* (1903).

sediments but re-arranged and recrystallised by heat and pressure and converted into various forms of gneiss and schist. Owing to the rigid exclusion of British travellers from Nepal, we know little or nothing of the geological characters of the highest mountain in the world, since practically the whole country is still unsurveyed. It is probable, however, that, like Kinchinjunga, the Everest group is composed chiefly of granite and gneiss.

To the west of Nepal we are on surer ground, since both Kumaun and Garhwal have been geologically surveyed. Here again the high peaks, such as Nanda Devi, the Kedarnath group, and Kamet,* are all composed of granite and gneiss with gneiss and schist on their flanks. The same may be said of most of the high peaks of Kashmir, including Nanga Parbat, Rakaposhi, and K²,† while granite is also probably the prevailing rock on Muztagh Ata and the other high peaks of the Kashgar range.

This correspondence between the great elevation and the geological structure of the high peaks appears to be too constant to be attributable to mere coincidence, and we are forced to the conclusion that their exceptional height is due to the presence of granite. This may be explained on two separate grounds, either (*a*) that the superior power of the granite to resist the atmospheric forces tending to their degradation has caused them to stand as isolated masses above surrounding areas of more easily eroded rocks, or (*b*) that they are areas of special elevation.

If now we examine the relationships of the peaks to one another, we find that along certain definite lines the intervening areas are also frequently composed of the same granite as the peaks themselves, and if we follow these definite lines we further find that they constitute the axes of the great mountain ranges. Thus the great peaks lie on more or less continuous and elevated zones composed of granite and crystalline rocks, and since the lower portions of the zones are of the same composition as the peaks themselves, it is difficult to regard the latter merely as relics of a once continuous zone of uniform height, and it seems probable that special elevating forces have been at work to raise certain parts of the zone above the general level of the whole; when once such elevation has been brought about, the disparity between the higher peaks and the intervening less elevated areas would undoubtedly be intensified by the destructive forces at work; the mantle of snow and ice, while slowly carrying on its own work of abrasion, will serve as a protection for the peaks against the disintegrating forces of the atmosphere, whilst the lower unprotected areas will be more rapidly eroded.

By the assumption that the higher peaks are due to special elevatory forces, it is not intended to imply that each peak is the result of an independent movement, for it has already been shown in a previous section of this paper that the peaks occur in well-marked clusters, any one of which may cover an area of many hundred square miles: when, therefore, during the development of the Himalaya as a mighty mountain range vast masses of granite welled up from below, forcing their way through and lifting up

* C. L. Griesbach, *Memoirs, Geological Survey of India*, Vol. XXIII (1891).

† R. Lydekker, *Memoirs, Geological Survey of India*, Vol. XXII (1883).

the pre-existing rocks above, it is probable that owing to dissimilarity of composition and structural weaknesses in certain portions of the earth's crust, movement was more intense at some points than at others, and that the granite was locally raised into more or less dome-like masses standing above the general level of the growing range: these masses were subsequently carved by the process of erosion into clusters of peaks. Whether the elevatory movement is still in progress it is not at present possible to say, but many phenomena observable throughout the Himalaya and Tibet lead us to infer that local elevation has until quite recently been operative, and the numerous earthquakes still occurring with such violence and frequency forcibly remind us that the Himalaya have by no means reached a period of even comparative rest.

CHART I

PEAKS OF THE FIRST MAGNITUDE

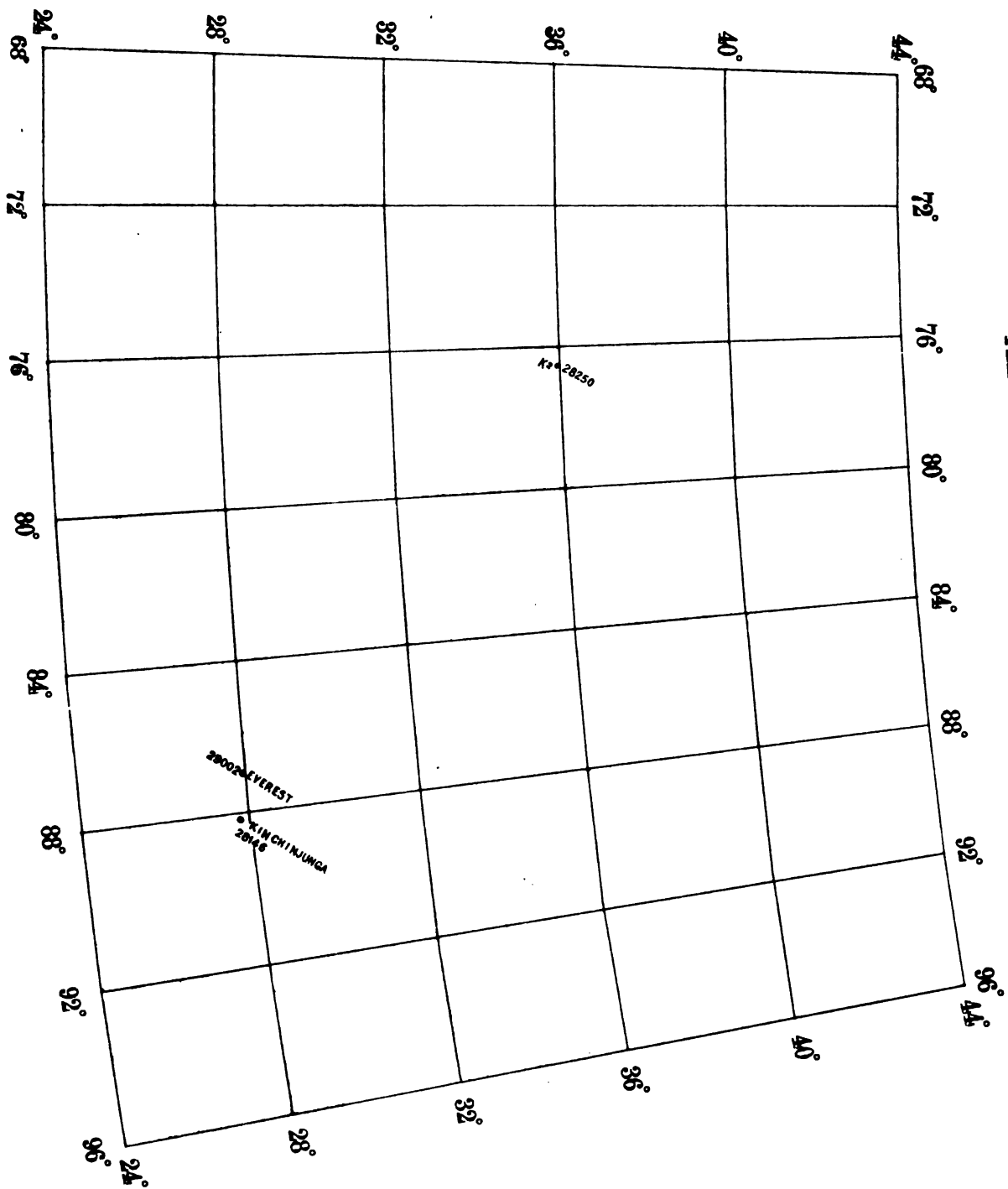


CHART II

PEAKS OF THE SECOND AND FIRST MAGNITUDE

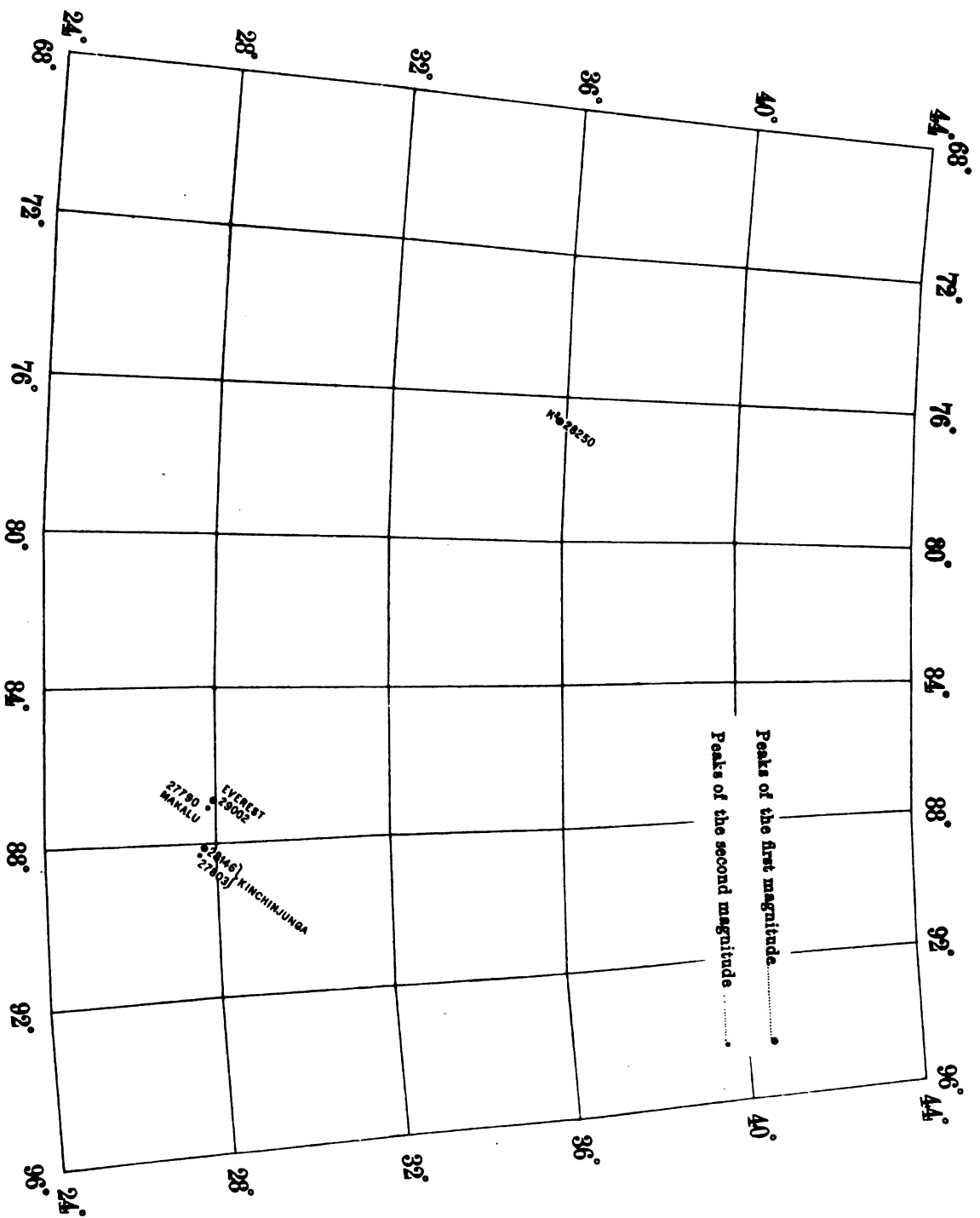


CHART III

PEAKS OF THE THIRD AND HIGHER MAGNITUDES

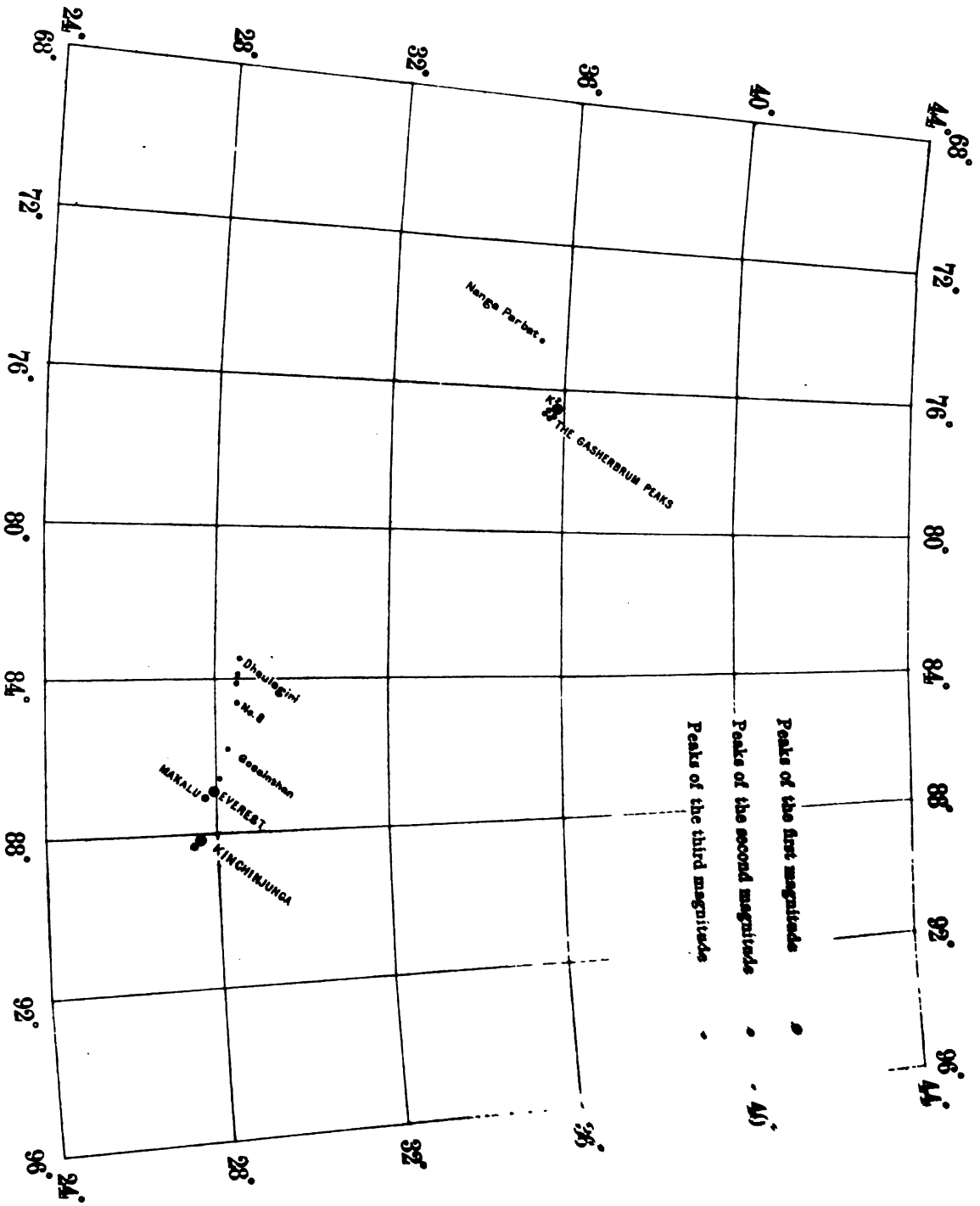


CHART IV

PEAKS OF THE FOURTH AND HIGHER MAGNITUDES

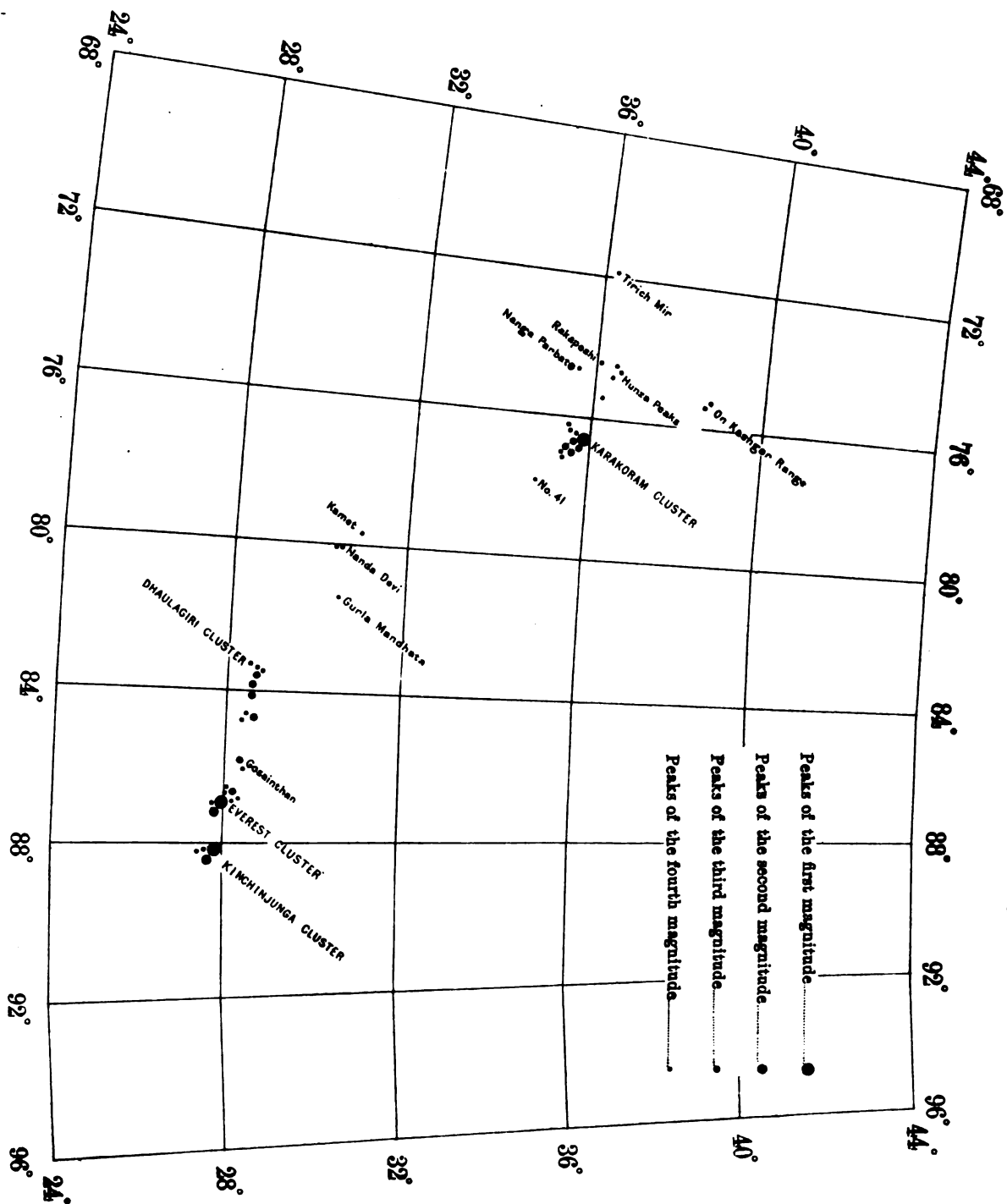
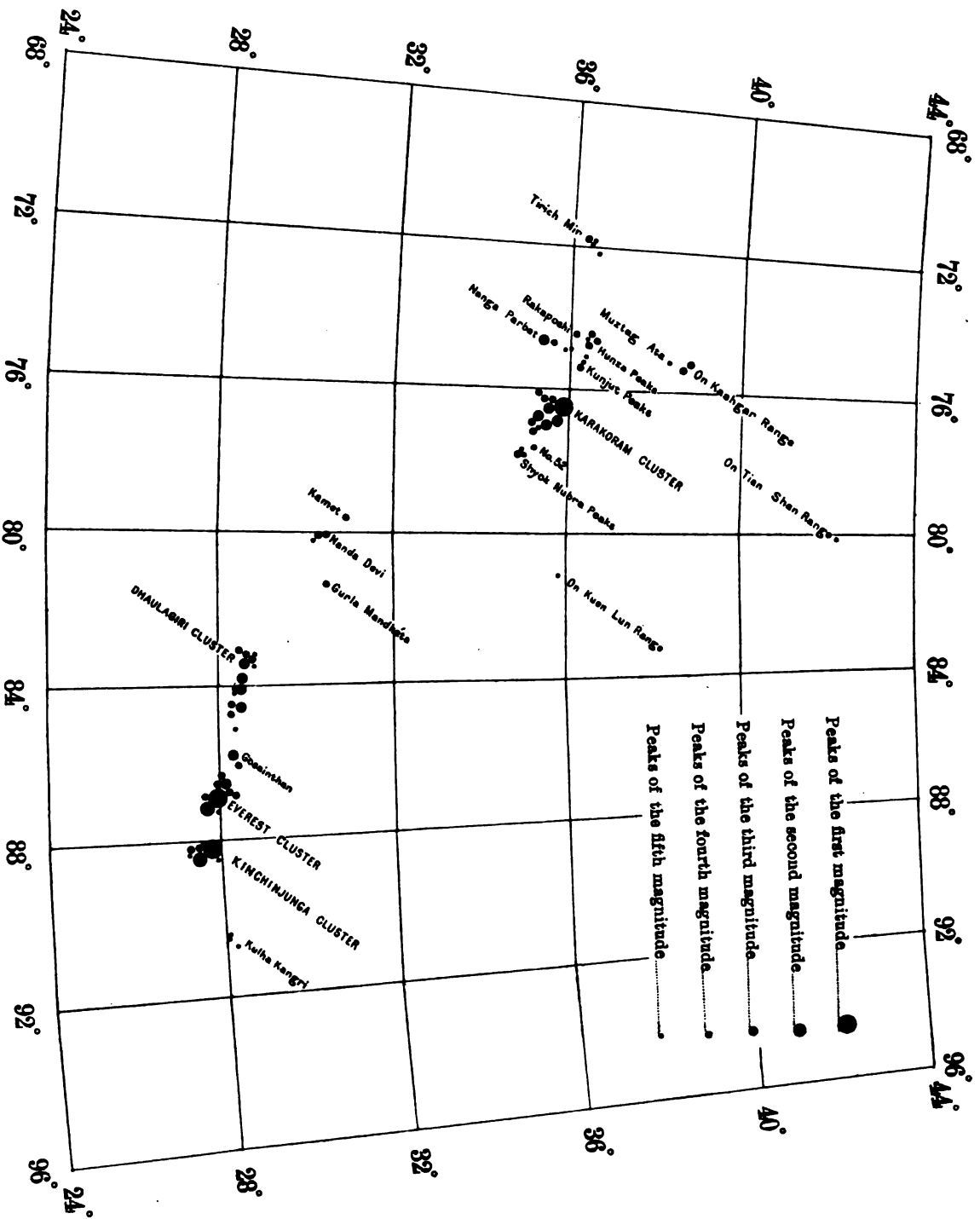


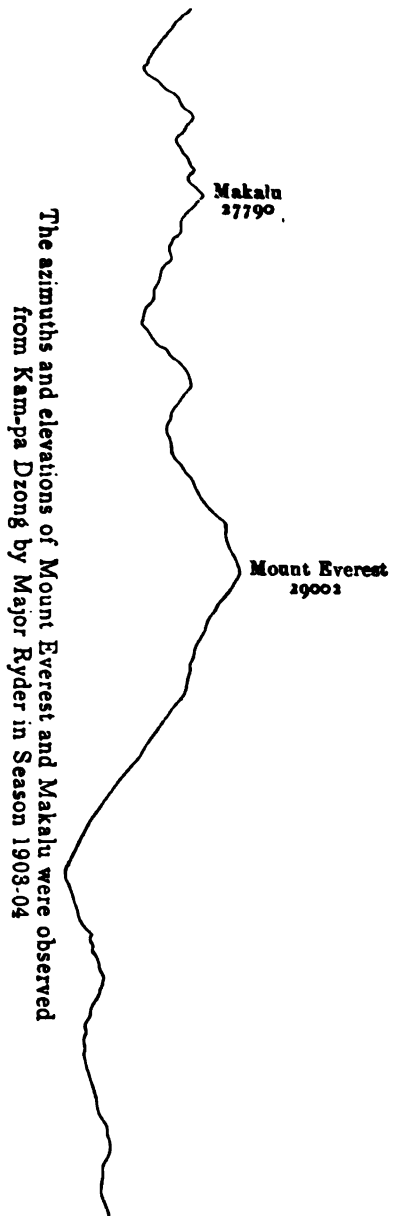
CHART V

PEAKS OF THE FIFTH AND HIGHER MAGNITUDES



Continuation of CHART VI

MAKALU and MOUNT EVEREST as seen from Kam-pa Dzong in Tibet



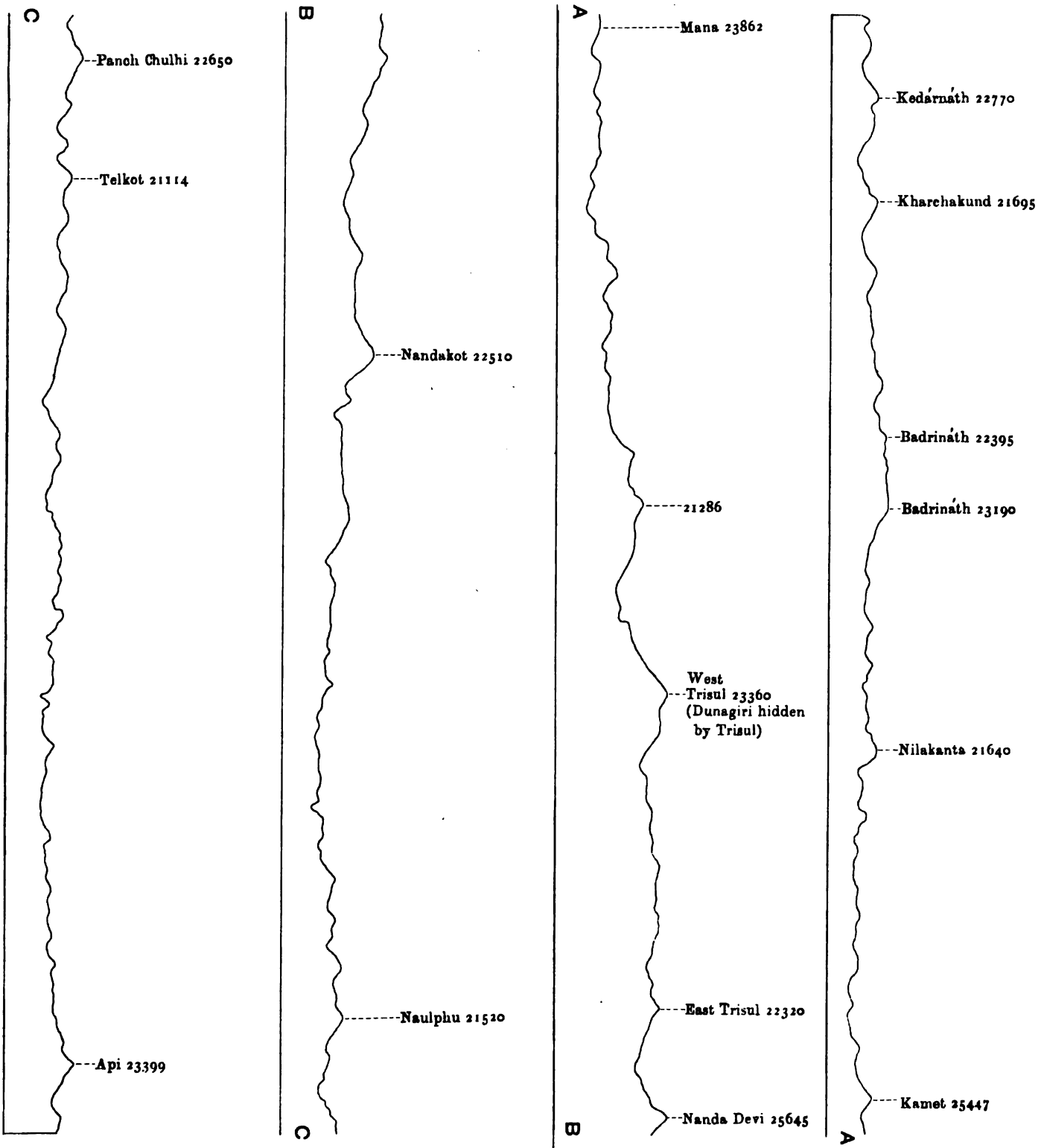
The azimuths and elevations of Mount Everest and Makalu were observed from Kam-pa Dzong by Major Ryder in Season 1903-04

**MAKALU and MOUNT EVEREST
as seen by Captain Wood from Pompa-zu-lung (height 18164 feet) in Tibet**



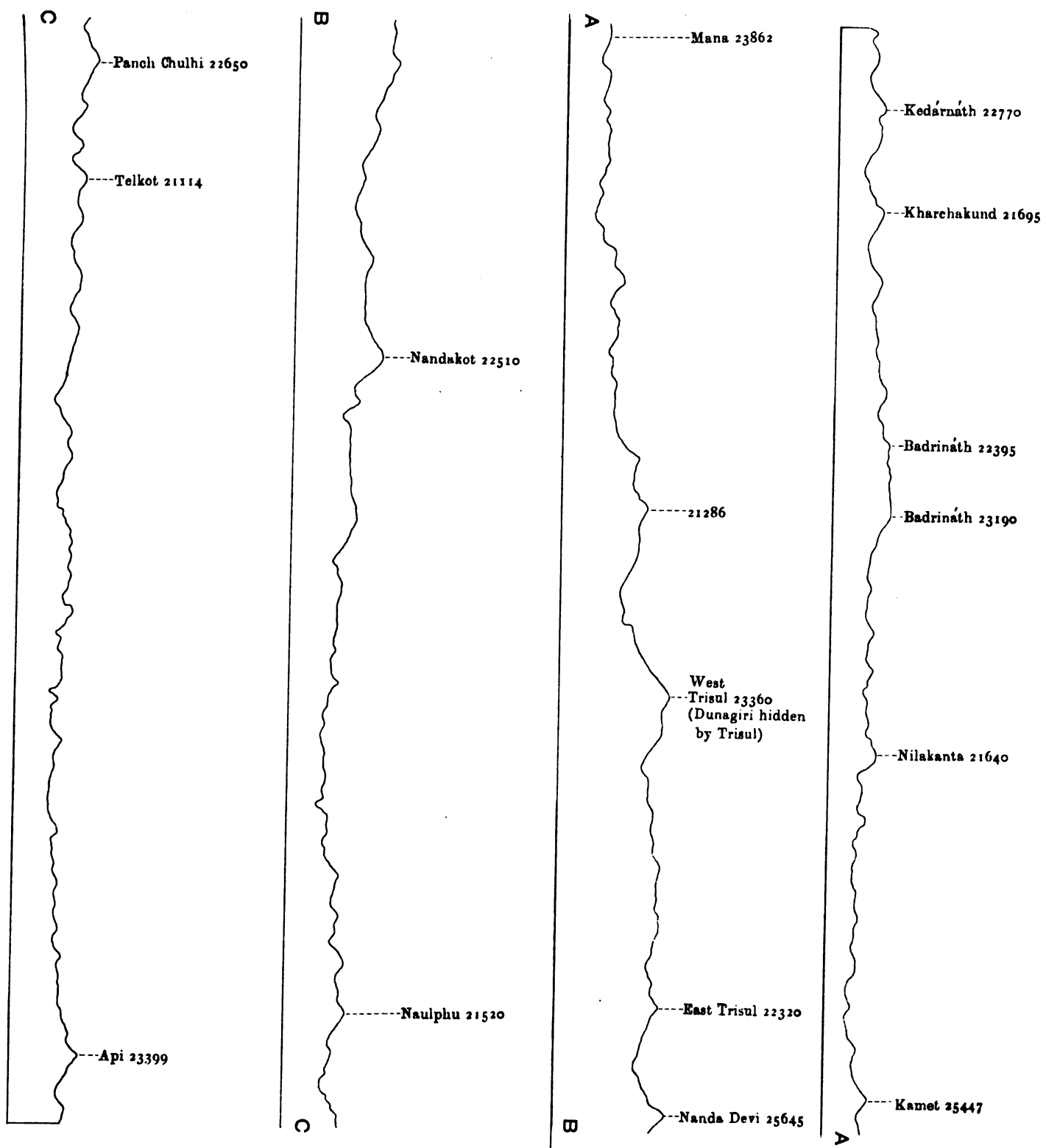
OUTLINE of the SNOWY RANGE as seen from Cheena (near Naini Tal)

CHART VII



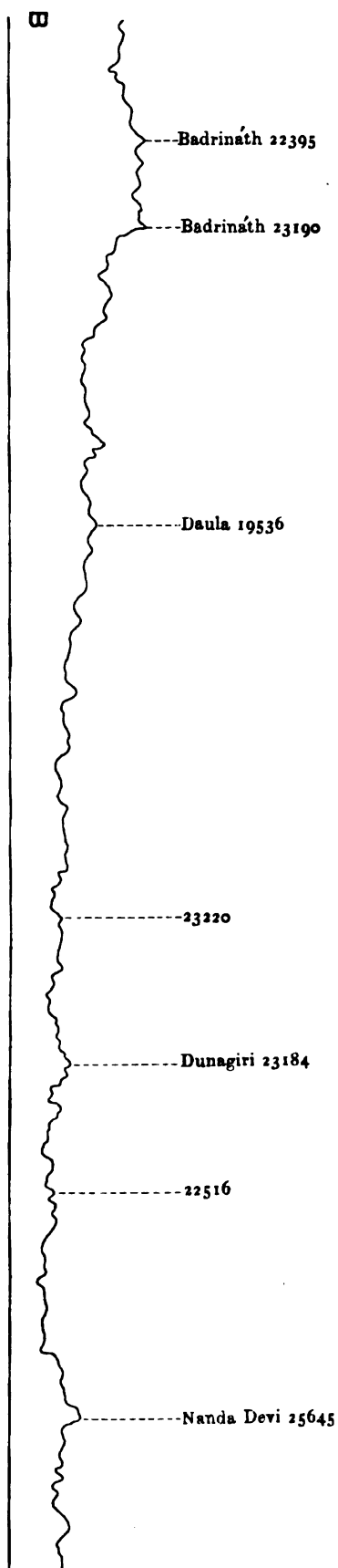
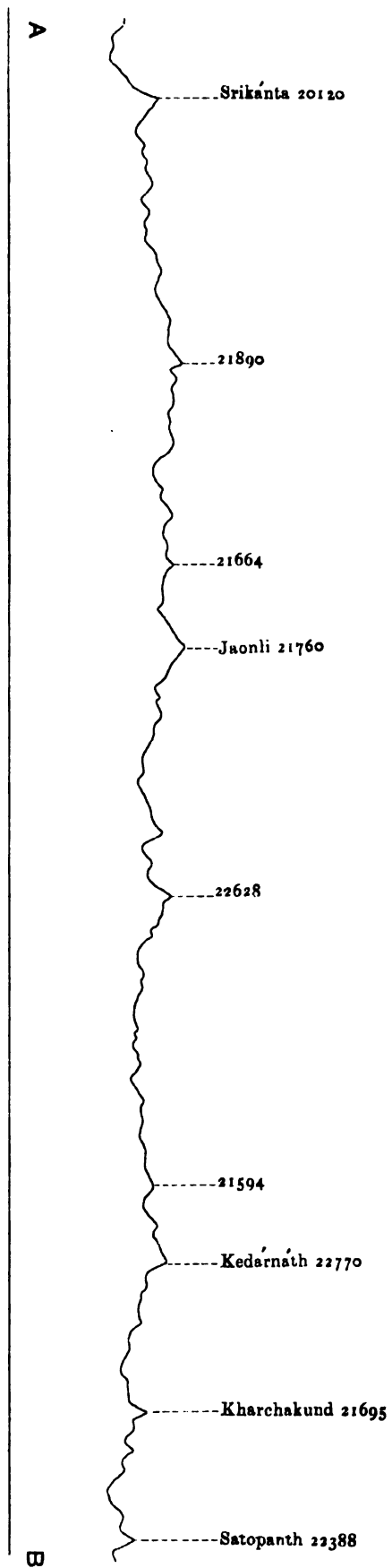
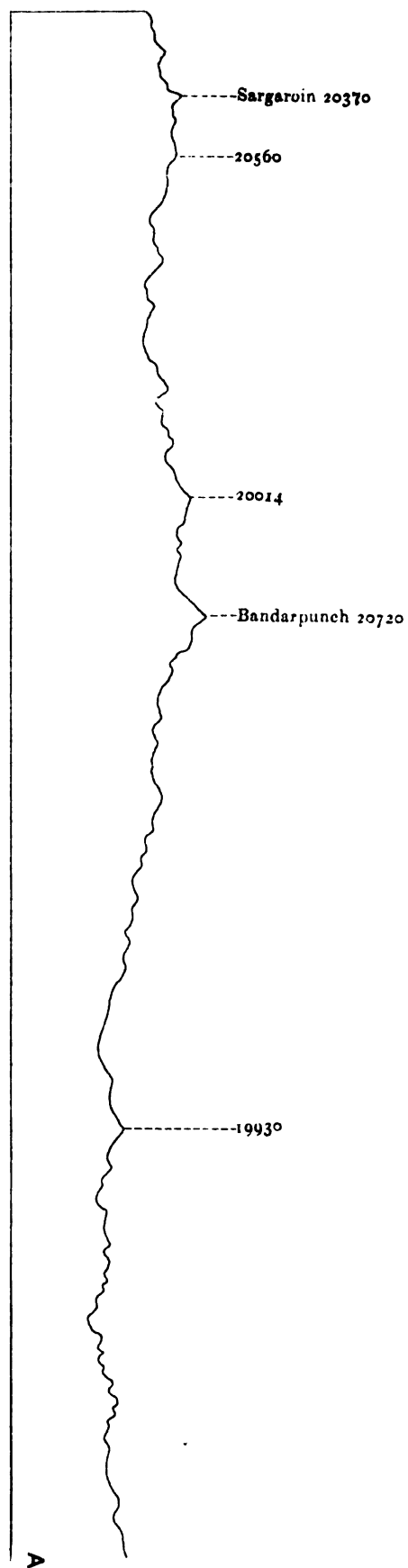
OUTLINE of the SNOWY RANGE as seen from Cheena (near Naini Tal)

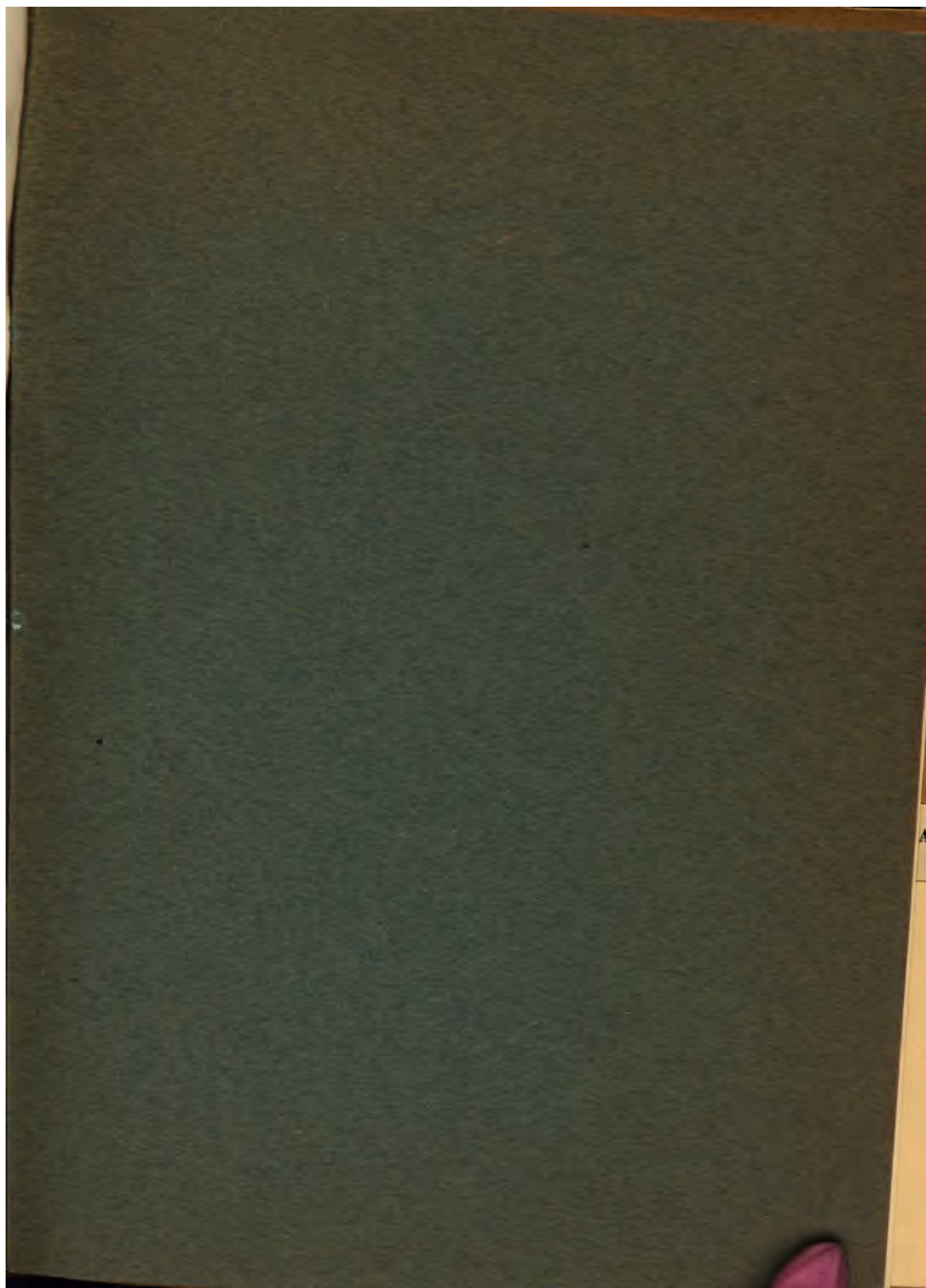
CHART VII



OUTLINE of the SNOWY RANGE as seen from Landour

CHART VIII







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